Vol. 20, No. 12
December 1995

Energy Research Abstracts

Abstracts 28576-31412

Office of Scientific and Technical Information
UNITED STATES DEPARTMENT OF ENERGY

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This information collection, containing over three million citations, represents a major national resource of scientific and technical information. In addition to information from DOE and its contractors, DOE acquires information through its international partnerships with the International Energy Agency's Energy Technology Data Exchange (ETDE), a consortium comprised of members from North America and Europe, Japan and Korea; the International Atomic Energy Agency's International Nuclear Information System, representing 80 countries; bilateral agreements with foreign governments; exchange agreements with other U.S. government agencies; and contracts with private information organizations and professional societies.

The subject scope of this information extends beyond energy, covering basic scientific studies in such areas as radiology, atomic and nuclear physics, radiation and nuclear chemistry, superconductivity, supercomputers, the environment, health and safety, waste management, nuclear medicine, and arms control.

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UNITED STATES DEPARTMENT OF ENERGY
Office of Scientific and Technical Information
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NOTICE

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Since March 1995 OSTI has made bibliographic information for Department of Energy (DOE) reports available electronically on the DOE Reports Bibliographic Database as well as through *Energy Research Abstracts*. This database can be accessed on the Internet via the DOE/OSTI Home Page at:

http://apollo.osti.gov/html/dra/dra.html

During these past months, the DOE Reports Bibliographic Database has proved to be an effective, cost-efficient, and well-received mechanism to provide these bibliographic data. Therefore, OSTI will discontinue publication of *Energy Research Abstracts* as of December 1995.

Bibliographic information for scientific and technical literature cited in *Energy Research Abstracts* also is available commercially via Knight-Ridder Information, Inc., on the Energy Science and Technology Database and via the Science and Technology Network (STN) on the Energy Database.

If you desire additional information call (423) 576-1222 or send E-mail to: usertalk@adonis.osti.gov.

Vol. 20, No. 12
December 1995
ISSN: 0160-3604
CODEN: ERABDZ

Energy Research Abstracts

Coverage

Energy Research Abstracts (ERA) provides abstracting and indexing coverage of all scientific and technical reports and patent applications originated by the U.S. Department of Energy, its laboratories, energy centers, and contractors, as well as theses and conference papers and proceedings issued by these organizations in report form. Audiovisual materials, computer media (magnetic tapes, diskettes, etc.), and engineering drawings are included in this definition. *ERA* also covers other energy information prepared *in report form* by federal and state government organizations, foreign governments, and domestic and foreign universities and research organizations, *provided* that the full text of the document has been received by OSTI. Foreign report information is obtained through the International Energy Agency's 18-nation Energy Technology Data Exchange, the International Atomic Energy Agency's International Nuclear Information System, or nation-to-nation agreements. The purpose of this publication is to announce documents produced or obtained by DOE that are not so readily available as journal articles, books, or patents.

Scope

The scope of *ERA* encompasses DOE's research, development, demonstration, and technology programs resulting from its broad charter for energy sources, supplies, safety, environmental impacts, and regulation.

The citations presented in *ERA* are available for online searching as records within the Energy Science and Technology Database (EDB). The current-year records are available on the Integrated Technical Information System (ITIS).

Availability

DOE and DOE contractors can obtain *ERA* (regular issues and annual indexes) by using VISA, MasterCard, or OSTI deposit accounts. Contact the Office of Scientific and Technical Information, P.O. Box 62, Oak Ridge, TN 37831, Attention: Information Services. For further information, call (423)576-8401. *ERA* is also available at authorized GPO Depository Libraries. (List is provided on the inside back cover.)

ERA (regular issues and annual indexes) is available to the public on a subscription basis from the Superintendent of Documents, U.S. Government Printing Office, Washington, D.C. 20402.

Managing Editor, Rita D. Boshears
Technical Editor, Barry C. Steele

Information Sources

The citations presented in *Energy Research Abstracts* are a subset of the worldwide energy information provided to the Office of Scientific and Technical Information (OSTI) through exchange agreements with foreign sources and through exchanges or contracts with U.S. organizations.

The **Energy Technology Data Exchange (ETDE)** was established by the International Energy Agency to promote cooperation among members in conducting appropriate energy-related research and development programs through the development of a formal central information sharing system. In accomplishing the objectives of the ETDE, members select, abstract, and index relevant research information published in their countries in accordance with Exchange standards. OSTI serves as the central receiving and processing center for this information, which it then disseminates to national centers in the participating countries. The following countries are currently members of the ETDE:

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- Denmark
- Finland
- France
- Germany
- Italy
- Japan
- Norway
- Poland
- Republic of Korea
- Spain
- Sweden
- Switzerland
- The Netherlands
- United Kingdom
- United States

The **International Nuclear Information System (INIS)** was established to promote the exchange of information on nuclear science and technology. Its operation is similar to that of the ETDE, with the INIS Secretariat being located in Vienna, Austria. Currently, 79 countries and 15 international organizations are members of INIS. OSTI serves as the INIS national center for the United States.

In the exercise of its rights and responsibilities under the agreements to which it is a party, the **Office of Scientific and Technical Information** both receives information from the above sources and submits U.S.-produced information to them. In addition to materials generated by the Department of Energy, this U.S.-produced information is gathered from other government agencies as well as under contract with private information processing companies. All input is computer processed and entered into a database for online retrieval. The database serves as well for the production of numerous OSTI publications.

How To Read A Citation

The principal data elements included in these citations are:

1. **Abstract number** within volume.
2. **Report number** identification for report-type literature.
3. **Title and subtitle** (non-English title may appear in parentheses, if applicable).
4. **Author(s).** First 10 names in the data record are printed, then "et al." is listed.
5. **Author affiliation.** Only first one is listed, in parentheses after author(s) to which it applies.
6. **Collaboration,** if present.
7. **Corporate author(s)** identifying corporation responsible for document.
8. **Date of publication.** If not known, a processing date is in brackets.
9. **Number of pages** or page range. Prices are based on total pages unless special pricing applies.
10. **Language** of document if non-English.
11. **Monograph title** if citation is an analytic (part, chapter, or paper) of a larger monograph.
12. **Sponsoring organization.**
13. **Contract or grant number.**
14. **Secondary identifying number;** may be a conference number.
15. **Conference title, location, and date,** if applicable.
16. **Order number.** The "DE" order number may be used for ordering from NTIS or OSTI, as appropriate. The "TI" prefix is valid only at OSTI.
17. **Sources of availability** from which a copy of the document may be obtained; usually appear as abbreviations. (See information on following page.)
18. **Drop note** or explanatory statement.
19. **Abstract.**
20. **Subject descriptors.** Listed only if no abstract or only a brief statement is included.

Sample Citations

Report

18494 (DOE/ER/40438–T1) **[Development of a hydrogen and deuterium polarized gas target for application in storage rings]: Progress report.** Haeberli, W. Phys. VI collaboration. **Wisconsin Univ., Madison (USA). Dept. of Physics.** [1989]. 12p. Sponsored by DOE Energy Research. DOE Contract FG02-88ER40438. Order Number DE89007246. **Available from NTIS, PC A03/MF A01 - OSTI; GPO Dep.**

This paper briefly discusses the Wisconsin test facility for storage cells; results of target tests; the new UHV...

Report Analytic

18500 (INIS-SU—69, pp. 30-32) **Transition energies in Ne-like ions. Correlation effects.** Vainshtejn, L.A. AN SSSR, Moscow. Fizicheskij Inst. 1988. (In Russian). In *Experimental and theoretical physics. Collection.* Order Number DE89780060. Available from NTIS (US Sales Only), PC A03/MF A01; INIS.

Kratkie Soobshcheniya po Fizike.; no. 6.

SILVER IONS/energy-level transitions; XENON IONS/energy-level transitions; CORRELATIONS; D STATES; E STATES;...

54 (DOE/ER/60888-1-Vol.1, pp. 115-117) **Investigation of air pollution in house due to use of various fuels.** Luo, Dayu (Chengdu Sanitation (China)). Canada Mortgage and Housing Corp., Ottawa, ON (Canada). 1990. (CONF-900724-Vol.1: Indoor Air '90: 5th international conference on indoor air quality and climate, Toronto (Canada), 29 Jul - 3 aug 1990). In Indoor air '90: The fifth international conference on indoor air quality and climate. Volume 1: Final report. 786p. Order Number DE90017786. Source: NTIS.

Air pollution in houses caused by combustion of coal is more serious than that by combustion of natural gas and methane (primarily by SO_2 and NO_2). The gas concentration after cooking is higher than that before cooking, and it is higher in kitchen than in bedroom and outdoor. There were mutations in the extract from TSP in $30m^2$ air in the bedroom, kitchen and outdoor, where coal and natural gas were used. The supernatant saliva activity of children whose family uses coal is significantly lower than that of pumping streams.

How To Order from the Availability Sources

TO OBTAIN A REPORT

Report literature, usually identified by an alphanumeric identifier at the beginning of a citation, is available from the sources listed in the citation (see example of element 2 on page iii). Often the sources are listed as abbreviations. Corresponding addresses are provided at right from which documents with these abbreviations may be ordered. When "OSTI" is given, **DOE and DOE contractors may order these documents from OSTI.** (However, check with your library or information organization which may require that orders go through them to OSTI.) OSTI prices are based on total pages unless special pricing applies. The public should order from NTIS or from one of the other agencies listed in the citation. NTIS price codes may continue to appear in some records. To expedite processing, an order form is provided in the back of this publication. NOTE: The order numbers provide quicker access for report ordering. Use the order number where possible.

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Government Printing Office
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INIS *Available only in microfiche.*
INIS Clearinghouse
International Atomic Energy Agency
P.O. Box 100, A-1400
Vienna, Austria

NTIS U.S. Department of Commerce
Technology Administration
National Technical Information Service
Springfield, VA 22161

OSTI U.S. Department of Energy
Office of Scientific and Technical Information
P.O. Box 62
Oak Ridge, TN 37831
Fax: (423) 576-2865
E-mail: reports@adonis.osti.gov

ESTSC Energy Science and Technology Software Center
P.O. Box 1020
Oak Ridge, TN 37831-1020

CASI Attention: Document Order
NASA Center for AeroSpace Information
800 Elkridge Landing Road
Linthicum Heights, MD 21090-2934

How To Use the Indexes

Five indexes are provided for approaching the content of each issue of *Energy Research Abstracts*. Descriptions of entries in these indexes follow.

Corporate Author Index
The corporation, organization, or institution responsible for the issuance of the document is listed in this index. The entries are arranged alphabetically and provide the title and citation number of the reference. For example, the listing for the "Report" sample citation would appear as shown at right.

Wisconsin Univ., Madison (USA). Dept. of Physics
[Development of a hydrogen and deuterium polarized gas target for application in storage rings]: Progress report, 15:18494 (R;US)
Wisconsin Univ., Madison (USA). Lab. of Genetics
Organization of the R chromosome region in maize: Final progress report, June 1, 1983–May 31, 1986, 15:18255 (R;US)

Personal Author Index
Each author's name listed on a document cited in this issue is indexed. An index entry provides title and citation number; for secondary and other names, a cross-reference is given to the primary author name where the full index entry is located.

Hadley, D.L., *See* Lee, A.D., 15:17651
Haeberli, W., [Development of a hydrogen and deuterium polarized gas target for application in storage rings]: Progress report, 15:18494 (R;US)

Subject Index
This index lists the main subject descriptors assigned to each record by indexing professionals. A secondary or qualifier term is used where necessary to describe materials, objects, and processes. Document titles may be enhanced with additional informative phrases where necessary. An excerpt from this index appears at right.

HYDROGEN ISOTOPES
See also DEUTERIUM
HYDROGEN 4
TRITIUM
Neutron-Rich Isotopes
Study on the strong neutron-rich nuclei of lightest elements, 15:18686 (RA;SU;In Russian)

Contract Number Index
DOE technical reports are listed by contract number. Each entry also provides the primary corporation or organization cited for that contract number. A typical entry is shown.

FG02-88ER40438 **Wisconsin Univ., Madison (USA). Dept. of Physics**
15:18494 DOE/ER/40438–T1
FG02-88ER60664 **Rogers and Associates Engineering Corp., Salt Lake City, UT (USA)**

Report Number Index
Technical report literature is indexed by the alphanumerical identifier of the report. Patent documents and conferences are included for convenience. Each entry lists the citation number, the source of availability of the document, an indicator of presence at a GPO depository library, order number, and distribution category. A typical entry is:

DOE/ER/40438–T1	15:18494	NTIS, OSTI	E 1.99: DE89007246	MF-411

Subject Contents

The subject content of *Energy Research Abstracts* is arranged as shown below. The two-digit and four-digit category numbers printed here illustrate the category number assignment used in the database records.* The following list includes all of the 38 first-level and the 313 second-level categories. Because each issue of *ERA* publishes citations only for those documents announced during the past semimonthly period, some subject categories may not be present in every issue.

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- 08 Waste Management
- 09 Environmental Aspects
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- 40 Health and Safety
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*The numerical subject category scheme is used in the storage, retrieval, and manipulation of bibliographic information entered into DOE's data systems. Categories and definitions for the complete set of six-digit numbers are given in ETDE/PUB--1-R2, *International Energy: Subject Categories and Scope*.

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Energy Research Abstracts

01 COAL, LIGNITE, AND PEAT

0103 Preparation

28576 (CONF-9507159–) **Eleventh annual coal preparation, utilization, and environmental control contractors conference: Proceedings.** USDOE Pittsburgh Energy Technology Center, PA (United States). [1995]. 440p. Sponsored by USDOE, Washington, DC (United States). From 11. annual coal preparation, utilization, and environmental control contractors conference; Pittsburgh, PA (United States); 12-14 Jul 1995. Order Number DE95017240. Source: OSTI; NTIS; GPO; INIS; GPO Dep.

The 75 papers contained in this volume are divided into the following sections: compliance technology; technology base activities; high efficiency preparation; air toxics (especially mercury); air toxics and CO_2 control; superclean emissions; Combustion 2000; advanced research; commercial and industrial combustion systems; alternative fuels; environmental control; and coal utilization. Selected papers are indexed separately for inclusion in the Energy Science and Technology Database.

28577 (DOE/MC/27362–4089) **Blast furnace granular coal injection project. Annual report, January–December 1994.** Bethlehem Steel Corp., PA (United States). Jul 1995. 43p. Sponsored by USDOE, Washington, DC (United States). DOE Contract FC21-91MC27362. Order Number DE95009736. Source: OSTI; NTIS; GPO Dep.

This annual report describes the Blast Furnace Granular Coal Injection project being implemented at Bethlehem Steel Corporation's (BSC) Burns Harbor Plant. The project is receiving cost-sharing from the US Department of Energy (DOE), and is being administrated by the Morgantown Energy Technology Center in accordance with the DOE Cooperative Agreement No. DE-FC21-91MC27362. This installation is the first in the United States to employ British Steel technology that uses granular coal to provide part of the fuel requirement of blast furnaces. The project will demonstrate/assess a broad range of technical/economic issues associated with the use of coal for this purpose. These include: coal grind size, coal injection rate, coal source (type) and blast furnace conversion method. To achieve the program objectives, the demonstration project is divided into the following three Phases: Phase I – design; Phase II – construction; and Phase III – operation. Preliminary design (Phase I) began in 1991 with detailed design commencing in 1993. Construction at Burns Harbor (Phase II) began in August 1993 and was completed at the end of 1994. A 100% construction review meeting was held in December and attended by representatives of DOE, Fluor Daniel and Bethlehem Steel. The coal preparation mills were started up in December, 1994, and the first coal was injected into "D" blast furnace on December 19, 1994. Near the end of the year, the grinding mills and injection facility were being prepared for performance testing during the first quarter of 1995. The demonstration test program (phase III) will start in the fourth quarter of 1995.

28578 (DOE/MT/92019–T3) **Effect of coal beneficiation process on rheology/atomization of coal water slurries. Quarterly progress report, November 1, 1994–January 31, 1995.** Ohene, F. Grambling State Univ., LA (United States). Dept. of Chemistry. [1995]. 13p. Sponsored by USDOE, Washington, DC (United States). DOE Contract FG22-92MT92019. Order Number DE96000932. Source: OSTI; NTIS; GPO Dep.

The overall objective of this project is to perform experiments to understand the effect of coal beneficiation processes and high shear rheological properties on the atomization of coal-water slurries (CWS). In the atomization studies, the mean drop size of the CWS sprays will be determined at various air to CWS. A correlation between the high shear rheological properties, particle size distributions and the atomization will be made in order to determine the influence of these parameters on the atomization of CWS. During this past quarter, the atomization data obtained from the previous quarters were analyzed using a model equation that had previously been developed during the course of this work. The analysis demonstrates that there are two possible mechanisms for the breakup of the CWS. The first term of the equation is due to competition between surface tension forces and aerodynamic shearing force and the second term is due the competition between viscosity forces and surface tension force.

28579 (DOE/MT/92019–T4) **Effect of coal beneficiation process on rheology/atomization of coal water slurries. Quarterly progress report, April 1, 1995–June 30, 1995.** Ohene, F. Grambling State Univ., LA (United States). Dept. of Chemistry. [1995]. 10p. Sponsored by USDOE, Washington, DC (United States). DOE Contract FG22-92MT92019. Order Number DE96000933. Source: OSTI; NTIS; GPO Dep.

The overall objective of this project is to perform experiments to understand the effect of coal beneficiation processes and high shear rheological properties on the atomization of coal-water slurries (CWS). In the atomization studies, the mean drop size of the CWS sprays will be determined at various air to CWS. A correlation between the high shear rheological properties, particle size distributions and the atomization will be made in order to determine the influence of these parameters on the atomization of CWS. Rheological properties of the CWS samples were determined after a six month storage period and the properties compared to freshly prepared samples. The rheological evaluations made include: flow characteristics under low shear rates; flow characteristics under high shear rates; and viscoelastic behavior under low frequency of oscillations. All the three CWS samples formed a hard pack solid at the end of the six month storage period, and had to be redispersed. The flotation cleaned coal and the heavy-media cleaned coal however, had the tendency to settle much faster than the uncleaned coal. Each of them remained completely dispersed during the duration of the testing period.

28580 (DOE/PC/89664–T11) **Advanced coal conversion process demonstration. Progress report, January 1, 1992–December 31, 1992.** Power Environmental Services, Inc., Butte, MT (United States). Dec 1993. 35p. Sponsored by USDOE, Washington, DC (United States). DOE Contract FC22-90PC89664. Order Number DE95017741. Source: OSTI; NTIS; GPO Dep.

This report contains a description of the technical progress made on the Advanced Coal Conversion Process (ACCP) Demonstration Project from January 1, 1992, through December 31, 1992. This project demonstrates an advanced thermal coal drying process, coupled with physical cleaning techniques, that is designed to upgrade high-moisture, low-rank coals to a high-quality, low-sulfur fuel, registered as the SynCoal® process. The coal is processed through three stages (two heating stages followed by an inert cooling stage) of vibrating fluidized bed reactors that remove chemically bound water, carboxyl groups, and volatile sulfur compounds. After drying, the coal is put through a deep-bed stratifier cleaning process to separate the pyrite-rich ash from the coal. The SynCoal® process enhances low-rank, western coals, usually with a moisture content of 25 to 55 percent, sulfur content of 0.5 to 1.5 percent, and heating value of 5,500 to 9,000 British thermal units per pound (Btu/lb), by producing a stable, upgraded, coal product with a moisture content as low as 1 percent, sulfur content as low as 0.3 percent, and heating value up to 12,000 Btu/lb. The 45-ton-per-hour unit is located adjacent to a unit train loadout facility at Western Energy Company's Rosebud coal mine near Colstrip, Montana. The demonstration plant is sized at about one-tenth the projected throughput of a multiple processing train commercial facility. The demonstration drying and cooling equipment is currently near commercial size. Rosebud SynCoal Partnership's ACCP Demonstration Facility entered Phase III, Demonstration Operation, in April 1992 and has been operating in an extended startup mode

since that time. As with any new developing technology, a number of unforeseen obstacles have been encountered; however, Rosebud SynCoal Partnership has instituted an aggressive program to overcome these obstacles.

28581 (DOE/PC/89664–T12) **Advanced coal conversion process demonstration. Progress report, January 1, 1992–March 31, 1992.** Western Energy Co., Colstrip, MT (United States). May 1992. 14p. Sponsored by USDOE, Washington, DC (United States). DOE Contract FC22-90PC89664. Order Number DE95017740. Source: OSTI; NTIS; GPO Dep.

This report contains a description of technical progress made on the Advanced Coal Conversion Process Demonstration Project (ACCP). This project will demonstrate an advanced thermal coal drying process coupled with physical cleaning techniques to upgrade high-moisture, low-rank coals to produce a high-quality, low-sulfur fuel. The coal will be processed through two vibrating fluidized bed reactors that will remove chemically bound water, carboxyl groups, and volatile sulfur compounds. After drying, the coal will be put through a deep-bed stratifier cleaning process effect separation of the pyrite rich ash. The process will enhance low-rank western coals, usually with a moisture content of 25–55%, sulfur content of 0.5–1.5%, and heating value of 5500–9000 Btu/lb by producing a stable, upgraded coal product with a moisture content as low as 1%, sulfur content as low as 0.3%, and heating value up to 12,0 00 Btu/lb. The 45 ton/hr unit will be located adjacent to a unit train loadout facility at Western Energy Company's Rosebud coal mine near the town of Colstrip in southeastern Montana. The demonstration plant is sized at about one-tenth the projected throughput of a multiple processing train commercia; facility. The demonstration drying and cooling equipment is currently commercial size.

28582 (DOE/PC/89766–T18) **Pelletization of fine coals. Final report.** Sastry, K.V.S. California Univ., Berkeley, CA (United States). Dept. of Materials Science and Mineral Engineering. [1995]. 150p. Sponsored by USDOE, Washington, DC (United States). DOE Contract FG22-89PC89766. Order Number DE96000976. Source: OSTI; NTIS; GPO Dep.

Coal is one of the most abundant energy resources in the United States with nearly 800 million tons of it being mined annually. Process and environmental demands for low-ash, low-sulfur coals and economic constraints for high productivity are leading the coal industry to use such modern mining methods as longwall mining and such newer coal processing techniques as froth flotation, oil agglomeration, chemical cleaning and synthetic fuel production. All these processes are faced with one common problem area – fine coals. Dealing effectively with these fine coals during handling, storage, transportation, and/or processing continues to be a challenge facing the industry. Agglomeration by the unit operation of pelletization consists of tumbling moist fines in drums or discs. Past experimental work and limited commercial practice have shown that pelletization can alleviate the problems associated with fine coals. This research program has been carried involving four specific topics: (i) experimental investigation of coal pelletization kinetics, (ii) understanding the surface principles of coal pelletization, (iii) modeling of coal pelletization processes, and (iv) simulation of fine coal pelletization circuits. This report summarizes the major findings and provides relevant details of the research effort. The effects of moisture and additives will be described.

28583 (DOE/PC/92205–T7) **Bench-scale testing of the multi-gravity separator in combination with microcel. Final report.** Luttrell, G.H. (Virginia Center for Coal and Minerals Processing, Blacksburg, VA (United States)); Venkatraman, P.; Phillips, D.I.; Yoon, Roe-Hoan. Virginia Center for Coal and Minerals Processing, Blacksburg, VA (United States); Carpco, Inc. (United States); Roberts and Schaefer Co., Salt Lake City, UT (United States); Consolidation Coal Co., Library, PA (United States); Kerr-McGee Corp., Oklahoma City, OK (United States). Mar 1995. 165p. Sponsored by USDOE, Washington, DC (United States). DOE Contract AC22-92PC92205. Order Number DE95016280. Source: OSTI; NTIS; GPO Dep.

It was the purpose of this investigation to test a new fine coal cleaning system, in which a coal is cleaned first by column flotation to remove primarily ash-forming minerals and then by an enhanced gravity separation technique to remove the pyrite remaining in the flotation product. Of the various column flotation technologies developed under the auspices of the US Department of Energy, the Microcel™ flotation column was chosen because it is being used commercially in the US coal industry, particularly by low-sulfur coal producers. Of the various enhanced gravity separation technologies used in minerals industry, Multi-Gravity Separator (MGS) was chosen because it shows promise for pyrite rejection from fine coal streams containing a wide range of particle sizes. The bench-scale tests were conducted using three different circuit configurations, i.e.; Microcel™ column alone; MGS alone; and Microcel™ and MGS in series. In general, high ash-rejections were achieved using Microcel™ column and an MGS unit in series, both the ash and pyritic sulfur rejections exceeded what can be achieved using either the Microcel™ column or the MGS unit alone, demonstrating a synergistic effect.

28584 (DOE/PC/92208–T10) **Engineering development of advanced physical fine coal cleaning for premium fuel applications. Quarterly progress report No. 10, January–March 1995.** Moro, N.; Shields, G.L.; Smit, F.J.; Jha, M.C. AMAX Research and Development Center, Golden, CO (United States). 27 Apr 1995. 44p. Sponsored by USDOE, Washington, DC (United States). DOE Contract AC22-92PC92208. Order Number DE95017739. Source: OSTI; NTIS; GPO Dep.

The primary goal of this project is the engineering development of two advanced physical fine coal cleaning processes, column flotation and selective agglomeration, for premium fuel applications. The project scope includes laboratory research and benchscale testing on six coals to optimize these processes, followed by design, and construction of a 2-t/hr process development unit (PDU). The PDU will then be operated to generate 200 ton lots of each of three project coals, by each process. The project began in October, 1992 and is scheduled for completion by June, 1997. During Quarter 10 (January–March, 1995), preliminary work continued for the Subtask 3.2 in-plant testing of the Microcel™ flotation column at the Lady Dunn Preparation Plant. Towards this end, laboratory flotation testing and refurbishing of the column have been started. The final version of the Subtask 4.2 Advanced Flotation Process Optimization Research topical report was issued, as was a draft version of the Subtask 4.3 report discussing the formulation of coal-water slurry fuels (CWF) from advanced flotation products. A number of product samples from Subtask 4.4 testing were sent to both Combustion Engineering and Penn State for combustion testing. The evaluation of toxic trace element analyses of column flotation products also continued. The detailed design of the 2 t/hr PDU was essentially completed with the approval of various process flow, plant layout, electrical, and vendor equipment drawings. The final version of the Subtask 6.5 – Selective Agglomeration Bench-Scale Design and Test Plan Report was issued during this reporting quarter. Design and construction of this 25 lb/hr selective agglomeration test unit was completed and preliminary testing started. Construction of the 2 t/hr PDU began following the selection of TIC. The Industrial Company as the construction subcontractor.

28585 (DOE/PC/92526–T11) **Rheology of coal-water slurries prepared by the HP roll mill grinding of coal. Quarterly technical progress report number 11, March 1–May 31, 1995.** Fuerstenau, D.W. California Univ., Berkeley, CA (United States). Jun 1995. 12p. Sponsored by USDOE, Washington, DC (United States). DOE Contract FG22-92PC92526. Order Number DE96000922. Source: OSTI; NTIS; GPO Dep.

The objective of this research is the development of improved technology for the preparation of coal-water slurries that have potential for replacing fuel oil in direct combustion. Detailed investigations of the effect of solids content and chemical additives on the rheology of coal-water slurries, prepared with fines produced by the ball milling of Pittsburgh No. 8 coal, were conducted during the first phase of the research program. These experiments were to provide a baseline against which the rheological behavior of slurries prepared with fines produced by high-pressure roll milling or hybrid high-pressure, roll mill/ball mill grinding could be compared. The viscosity of slurries with high solids content is strongly influenced by the packing density of the feed material. The packing

density can be significantly altered by mixing distributions of different median sizes, and to an extent by modifying the grinding environment. The research during this quarter was, therefore, directed towards: (1) establishing the relationship between the packing characteristic of fines and the viscosity of slurries prepared with the fines; (2) investigation of the effect of mixing distribution on the rheology; and (3) study of the effect of grinding environment in the ball mill on the rheology of coal-water slurries.

28586 (DOE/PC/92547–9) **Controlling incipient oxidation of pyrite for improved rejection. Technical progress report for the ninth quarter, October 1–December 31, 1994.** Yoon, R.H.; Richardson, P.E. Virginia Polytechnic Inst. and State Univ., Blacksburg, VA (United States). Dept. of Mining and Minerals Engineering. Jul 1995. 13p. Sponsored by USDOE, Washington, DC (United States). DOE Contract FG22-92PC92547. Order Number DE96000903. Source: OSTI; NTIS; GPO Dep.

The major objectives of this work are (1) to determine the Eh-pH conditions under which pyrite is stable, (2) to determine the mechanism of the initial stages of pyrite oxidation, and (3) to determine if the semi-conducting properties of pyrite effects its oxidation behavior. It is known that moderate oxidation of pyrite produces a hydrophobic surface product. This hydrophobic product makes it extremely difficult to depress pyrite in coal flotation circuits. The eventual objective of this work is to prevent pyrite oxidation in order to better depress pyrite in coal flotation circuits. It has been shown that by holding the potential of pyrite at its stable potential during fracture, pyrite undergoes neither oxidation nor reduction. It has also been found that fresh pyrite surfaces created by fracture in an electrochemical begin to oxidize at potentials that are about 200 mV more negative than the potentials reported in the literature for pyrite oxidation. This report period, electrochemical impedance spectroscopy (EIS) studies were continued. As discussed in the seventh quarterly progress report, the impedance of pyrite does not show the characteristics expected for either semi-conducting or metallic electrodes. Additional studies were conducted to confirm the anomalous impedance behavior. For this purpose, freshly fractured surfaces were progressively polished on 600 and 1,200 grit silicon carbide paper, and with 0.3 μ α-alumina and 0.05 μ γ-alumina micropolish. Polishing is known to introduce defects in the lattice structure of semi-conducting electrodes and it was anticipated that the defects would effect the interfacial capacitance.

28587 (DOE/PC/92547–T8) **Controlling incipient oxidation of pyrite for improved rejection. Eighth quarterly technical progress report, July 1, 1994–September 30, 1994.** Yoon, R.H.; Richardson, P.E. Virginia Polytechnic Inst. and State Univ., Blacksburg, VA (United States). Dept. of Mining and Minerals Engineering. [1994]. 6p. Sponsored by USDOE, Washington, DC (United States). DOE Contract FG22-92PC92547. Order Number DE95017746. Source: OSTI; NTIS; GPO Dep.

The major objectives of this work are (1) to determine the Eh-pH conditions under which pyrite is stable, (2) to determine the mechanism of the initial stages of pyrite oxidation and (3) to determine if the semi-conducting properties of pyrite effects its oxidation behavior. It is known that moderate oxidation of pyrite produces a hydrophobic surface product. This hydrophobic product makes it extremely difficult to depress pyrite in coal flotation circuits. The eventual objective of this work is to prevent pyrite oxidation in order to better depress pyrite in coal flotation circuits. In this work clean, unoxidized pyrite surfaces are being produced by fracturing pyrite electrodes in an electrochemical cell. It has been shown that pyrite assumes a unique potential referred to as the "stable potential" at the instance it is fractured and that this potential is several hundred millivolts more negative than the steady state mixed potential of pyrite. It has also been shown that by holding the potential of pyrite at its stable potential during fracture, pyrite undergoes neither oxidation nor reduction. It has also been found that fresh pyrite surfaces created by fracture in an electrochemical begin to oxidize at potentials that are about 200 mV more negative than the potentials reported in the literature for pyrite oxidation. This is attributed to the fact that most work on pyrite has employed polished electrodes that have pre-existing oxidation products on the surface. The existence of a pH dependent stable potential for freshly fractured pyrite electrodes was based on studies conducted mainly on pyrite from Peru.

28588 (DOE/PC/92550–10) **Evaluation of hyperbaric filtration for fine coal dewatering. Tenth quarterly technical progress report, January 1, 1995–March 31, 1995.** Parekh, B.K. (Kentucky Univ., Lexington, KY (United States). Center for Applied Energy Research); Leonard, J.W.; Hogg, R.; Fonseca, A. Kentucky Univ., Lexington, KY (United States). Center for Applied Energy Research. [1995]. 46p. Sponsored by USDOE, Washington, DC (United States). DOE Contract FG22-92PC92550. Order Number DE95017756. Source: OSTI; NTIS; GPO Dep.

The main objectives of the project are to investigate the fundamental aspects of particle-liquid interaction in fine coal dewatering, to conduct laboratory and pilot plant studies on the applicability of hyperbaric filter systems and to develop process conditions for dewatering of fine clean coal to less than 20 percent moisture. The program consist of three phases: Phase I, model development; Phase II, laboratory studies; and Phase III, field testing. The Pennsylvania State University is leading efforts in Phase I, the University of Kentucky in Phase II, and Consol Inc. in Phase III of the program. All three organizations are involved in-all the three phases of the program. The Pennsylvania State University is developing a theoretical model for hyperbaric filtration systems, whereas the University of Kentucky is conducting experimental studies to investigate fundamental aspects of particle-liquid interaction and application of high pressure filter in fine coal dewatering. The optimum filtration conditions identified in Phase I and II will be tested in a Consol Inc. coal preparation plant using an Andritz Ruthner portable hyperbaric filtration unit. Accomplishments are discussed for all three phases of study.

28589 (DOE/PC/94202–T3) **Hydrothermally treated coals for pulverized coal injection. [Quarterly] technical progress report, January–March 1995.** Walsh, D.E.; Rao, P.D.; Ogunsola, O.; Lin, H.K. Alaska Univ., Fairbanks, AK (United States). School of Mineral Industry. Apr 1995. 17p. Sponsored by USDOE, Washington, DC (United States). DOE Contract FG22-94PC94202. Order Number DE95017745. Source: OSTI; NTIS; GPO Dep.

This project is investigating the suitability of hydrothermally dried low-rank coals for pulverized fuel injection into blast furnaces in order to reduce coke consumption. Coal samples from the Beluga coal field and the Usibelli Coal Mine, Alaska, are being used for the study. Crushed coal samples were hydrothermally treated at three temperatures, 275, 300 and 325°C, for residence times ranging from 10 to 120 minutes. Products are being characterized to determine their suitability for pulverized coal injection. Characterization includes proximate and ultimate analyses, vitrinite reflectance and TGA reactivity. A literature survey is being conducted.

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Refer also to citation(s) 28638, 28641, 28658, 28659, 28667, 29272, 29428

28590 (CONF-950402–12) **The role of recycle oil in direct coal liquefaction process development.** Burke, F.P. CONSOL, Inc., Library, PA (United States). Research and Development Dept. [1995]. 6p. Sponsored by USDOE, Washington, DC (United States);Electric Power Research Inst., Palo Alto, CA (United States). DOE Contract AC22-94PC93054. From 209. American Chemical Society (ACS) national meeting; Anaheim, CA (United States); 2-6 Apr 1995. Order Number DE95016572. Source: OSTI; NTIS; GPO Dep.

It has long been recognized that use of a recycle oil is a convenient and perhaps necessary feature of a practical direct coal liquefaction process. The recycle oil performs a number of important functions. It serves as a vehicle to convey coal into the liquefaction reactor and products from the reactor. It is a medium for mass and heat transfer among the solid, liquid, and gaseous components of the reactor inventory. It can act as a reactant or intermediate in the liquefaction process. Therefore, the nature of the recycle oil can have a determining effect on process configuration and performance, and the characterization of recycle oil composition and chemistry has been the subject of considerable interest.

This paper discusses recycle oil characterization and its influence on the industrial development of coal liquefaction technology.

28591 (CONF-950402–13) **Characterization of coal/waste coprocessing samples from HRI Run POC-2.** Robbins, G.A.; Winschel, R.A.; Burke, F.P. CONSOL, Inc., Library, PA (United States). Research and Development Dept. [1995]. 5p. Sponsored by USDOE, Washington, DC (United States). DOE Contract AC22-94PC93054. From 209. American Chemical Society (ACS) national meeting; Anaheim, CA (United States); 2-6 Apr 1995. Order Number DE95016573. Source: OSTI; NTIS; GPO Dep.

Coal and waste materials (plastics and rubber) were co-liquefied during Run POC-2 in HRI's 3 T/D direct liquefaction process development unit under the DOE sponsored Proof-of-Concept program. Analytical characterizations were conducted of well-defined samples from representative periods of the run to provide information on the chemical transformation of these feedstocks and their distribution in product and recycle streams. The characteristics of the products and process streams were dependent on both feedstock changes and operating conditions. Several unusual process oil characteristics were observed when wastes were coprocessed with coal, especially during the coal/plastic operation. Implications of these results for future coal/waste liquefaction development and analytical characterization of the materials are discussed.

28592 (DOE/MC/24257–5003) **Integrated low emissions cleanup system for direct coal fueled turbines: (moving bed, fluid bed contactor/ceramic filter). Thirtieth quarterly report for the period January–March 1995.** Newby, R.A.; Alvin, M.A.; Bachovchin, D.M.; Yang, W.C.; Smeltzer, E.E.; Lippert, T.E. Westinghouse Electric Corp., Pittsburgh, PA (United States). Science and Technology Center. [1995]. 120p. Sponsored by USDOE, Washington, DC (United States). DOE Contract AC21-87MC24257. Order Number DE96000878. Source: OSTI; NTIS; GPO Dep.

The United States Department of Energy, Morgantown Energy Research Center (DOE/METC), is sponsoring the development of advanced, coal-fueled turbine power plants such as pressurized fluid bed combustion and coal gasification combined cycles. A major technical challenge remaining for the development of the coal-fueled turbine is high-temperature gas cleaning to meet environmental standards for sulfur oxides and particulate emissions, as well as to provide acceptable turbine life. The Westinghouse Electric Corporation, Science & Technology Center, is evaluating Integrated Low Emissions Cleanup (ILEC) concepts that have been configured to meet this technical challenge. These UEC concepts simultaneously control sulfur, particulate, and alkali contaminants in the high-pressure process gases. This document reports the status of a program in the thirtieth quarter to develop this ILEC technology. During this Quarter of the program, the Phase In bench-scale, high-temperature, high-pressure (HTHP) testing of PFBC fly ashes was continued. Tests have been completed to characterize the filter cake pulse cleaning, as a function of temperature. The behavior trends are consistent with field unit observations. Sulfur removal tests, looking at the influence of SO_2 on filter cake permeability, as well as the ability to remove sulfur by injecting dolomite into the filter, have been completed. Alkali removal tests were initiated this quarter injecting emathlite into the filter. A complete summary of the test procedures; tests completed and test results is presented in Appendices A, B and C. Preparation has been made to prepare the Phase III final report.

28593 (DOE/MC/25140–5005) **Hot gas cleanup test facility for gasification and pressurized combustion. Quarterly report, April–June 1995.** Southern Co. Services, Inc., Birmingham, AL (United States). Aug 1995. 90p. Sponsored by USDOE, Washington, DC (United States). DOE Contract FC21-90MC25140. Order Number DE95009740. Source: OSTI; NTIS; GPO Dep.

This quarterly technical progress report summarizes the work completed during the first quarter, April 1 through June 30, 1995. The objective of this project is to evaluate hot gas particle control technologies using coal-derived gas streams. This will entail the design, construction, installation, and use of a flexible test facility which can operate under realistic gasificafion and combustion conditions. The major particulate control device issues to be addressed include the integration of the particulate control devices into coal utilization systems, on-line cleaning techniques, chemical and thermal degradation of components, fatigue or structural failures, blinding, collection efficiency as a function of particle size, and scale-up of particulate control systems to commercial size. The conceptual design of the facility was extended to include a within scope, phased expansion of the existing Hot Gas Cleanup Test Facility Cooperative Agreement to also address systems integration issues of hot particulate removal in advanced coal-based power generation systems. This expansion included the consideration of the following modules at the test facility in addition to the original Transport Reactor gas source and Hot Gas Cleanup Units: Carbonizer/pressurized circulating fluidized bed gas source; hot gas cleanup units to mate to all gas streams; combustion gas turbine; and fuel cell and associated gas treatment. The major emphasis during this reporting period was continuing the detailed design of the facility towards completion and integrating the particulate control devices (PCDS) into the structural and process designs. Substantial progress in construction activities was achieved during the quarter. Delivery and construction of the process structural steel continued at a good pace during the quarter.

28594 (DOE/MT/94010–T1) **Advance concepts for conversion of syngas to liquids. Quarterly report, September 28, 1994–January 28, 1995.** Szostak, R.; Abotsi, G.; Mitchell, M.; Ingram, C. Clark Atlanta Univ., GA (United States). [1995]. 16p. Sponsored by USDOE, Washington, DC (United States). DOE Contract FG22-94MT94010. Order Number DE96000918. Source: OSTI; NTIS; GPO Dep.

In this study, MeAPO-36 was crystallized from a reaction mixture of molar composition 1.8 Pr_3N; 0.156 MgO; 0.97 Al_2O_3; 0.936 P_2O_5; 41.4H_2O; and 0.31 HOAC at 100 C for 48 h followed by 150 C for 24 to 72 h. Its formation was dependent on the source of aluminum, template concentration and the reaction temperature and time. MeAPO-5 was a competing impurity phase and its formation can be suppressed by changes in the reaction conditions. The report includes a discussion of the synthesis procedure for MeAPO-36 and its characterization by x-ray diffraction.

28595 (DOE/MT/94010–T2) **Advance concepts for conversion of syngas to liquids. Quarterly report number 2, January 29–April 28, 1995.** Szostak, R.; Abotsi, G.; Mitchell, M.; Ingram, C.; Dai, E.; McClure, C.; Silimon, D. Clark Atlanta Univ., GA (United States). [1995]. 21p. Sponsored by USDOE, Washington, DC (United States). DOE Contract FG22-94MT94010. Order Number DE96000919. Source: OSTI; NTIS; GPO Dep.

MeAPO-36 containing various types and concentrations of metals (Mn, Co, Mg and Zn) in the reaction mixture were synthesized. Various levels of crystallinity were observed depending on the type and concentration of these metals and crystallization parameter. Calcination of the samples at 550 C resulted in varying levels of reduction in crystallinity depending on the type of divalent metal incorporated. MeAPO-36 had the highest thermal stability. Ammonia TPD and IR spectrum of pyridine absorption show that MeAPO-36 have concentrations of both Bronsted and Lewis acid sites. Preliminary catalytic evaluation on a wide range of MeAPOs (metal-containing aluminophosphates) show that they were active for the hydroxylation of phenol. Results are presented.

28596 (DOE/PC/88819–T18) **Catalysts and process development for two-stage liquefaction. First quarterly report, January 1, 1992–March 31, 1992.** Cronauer, D.C.; Swanson, A.J.; Sajkowski, D.J. Amoco Oil Co., Naperville, IL (United States). Research and Development Dept. [1992]. 42p. Sponsored by USDOE, Washington, DC (United States). DOE Contract AC22-88PC88819. Order Number DE95017772. Source: OSTI; NTIS; GPO Dep.

Research under way in this project centers upon developing and evaluating catalysts and process improvements for coal liquefaction in the two-stage, close-coupled catalytic process. The project is being carried out under contract to the United States Department of Energy. As discussed in the previous quarterly report, promising results were obtained by liquefying Illinois No. 6 bituminous and Black Thunder subbituminous coals using oil-soluble catalysts Molyvan L and molybdenum octoate. In this quarter, the liquefaction of Black Thunder coal was continued. Runs were made in catalytic/thermal (C/T) mode with supported AMOCAT™ 1C (NiMo) and AMOCAT™ 1B (Mo) catalysts. Although the initial performance in these runs was good (90% conversion with no resid production),

both catalysts deactivated rapidly. Spent catalysts showed severe coke deposition as well as formation of a calcium-rich shell on the catalyst surface. Overall, C/T liquefaction is not a good process option for Black Thunder coal.

28597 (DOE/PC/88819–T19) **Catalysts and process developments for two-stage liquefaction. Second quarterly progress report, April 1, 1992–June 30, 1992.** Cronauer, D.C.; Swanson, A.J.; Sajkowski, D.J. Amoco Oil Co., Naperville, IL (United States). Research and Development Dept. [1992]. 43p. Sponsored by USDOE, Washington, DC (United States). DOE Contract AC22-88PC88819. Order Number DE95017770. Source: OSTI; NTIS; GPO Dep.

Research under way in this project centers upon developing and evaluation catalysts and process improvements for coal liquefaction in the two-stage close-coupled catalytic process. The project is being carried out under contract to the United States Department of Energy. As discussed in the previous quarterly report, the results showed that C/T liquefaction is not a good option for Black Thunder subbituminous coal. In this quarter, the liquefaction of Black Thunder coal was continued. The studies showed that the combination of Wender's sulfated iron oxide with molybdenum is the most effective catalyst for this liquefaction. Compared with other iron/molybdenum catalysts, distillate yields were increased and the catalyst deactivation was not as severe as for the supported (extruded) catalysts.

28598 (DOE/PC/90048–T4) **Fine particle clay catalysts for coal liquefaction. Quarterly technical progress report, February 9, 1993–May 8, 1993.** Olson, E.S. Universal Fuel Development Associates, Inc., Grand Forks, ND (United States). [1995]. 14p. Sponsored by USDOE, Washington, DC (United States). DOE Contract AC22-91PC90048. Order Number DE96000973. Source: OSTI; NTIS; GPO Dep.

An investigation of new methods for the production and utilization of tetralin-soluble iron oxometallate precursors for coal liquefaction catalysts was continued in this quarter. Further descriptions of the catalytic activities of the sulfided forms were obtained. The hydrogenation activities of catalysts derived from iron oxotitanate and cobalt oxoaluminate were investigated using pyrene as a the test compound, and results were compared with thermal reactions. The hydrogenation activity of iron oxotitanate was superior to other catalysts including iron oxoaluminate. The hydrogenation activity of cobalt oxoaluminate was similar to that of iron oxoaluminate reported in previous quarterly report. The liquefaction of Wyodak subbituminous coal was investigated using in situ sulfided iron oxotitanate catalyst. In order to improve the usefulness of iron oxoaluminate as a liquefaction catalyst, iron oxoaluminate was supported on acid-treated montmorillonite (K-10). Supporting the iron oxoaluminate on an acidic support significantly improved the hydrogenation activity of iron oxoaluminate. The hydrocracking activity was increased by a large factor. Thus the aluminate and titanate structures surrounding the pyrrhotite that forms during sulfidation have a beneficial effect in preventing deactivation of the iron sites, and the presence of the acidic sites in the clay results in effective catalytic synergism between catalyst and support. These clay-supported iron oxometallates are highly promising catalysts for coal liquefaction. Iron oxyhydroxide and triiron supported on acid-treated montmorillonite (K-10) were tested for the liquefaction of ion-exchanged Wyodak (IEW) to minimize effects of the coal mineral matter. Both sulfided catalysts gave very high conversions of coal to THF-soluble and heptane-soluble (oils) products.

28599 (DOE/PC/90048–T5) **Fine particle clay catalysts for coal liquefaction. Quarterly technical progress report, May 8, 1993–August 8, 1993.** Olson, E.S. Universal Fuel Development Associates, Inc., Grand Forks, ND (United States). [1995]. 12p. Sponsored by USDOE, Washington, DC (United States). DOE Contract AC22-91PC90048. Order Number DE96000972. Source: OSTI; NTIS; GPO Dep.

High hydrocracking and liquefaction activity can be achieved with 10 wt.% of sulfided clay-supported iron catalysts. Further tests and demonstrations of this activity were required. Iron hydroxyoxide was generated on acid-treated montmorillonite. The new batch of catalyst exhibited high hydrocracking activity, Three hour tests with the solubilized intermediate from low-severity treatment of Wyodak coal (LSW) gave a high conversion (45%) of the heptane-insoluble LSW intermediate to heptane-soluble products. An investigation of new methods for the production of catalysts from tetralin-soluble iron oxometallates and the determination of their catalytic activities was continued in this quarter. Iron oxotitanate and iron oxoaluminate gave very high conversions of LSW to heptane solubles (61% and 54%, respectively). The high yields of heptane soluble products obtained with these catalysts offers a potential for use in liquefaction stages with solubilized coal, or at least serve as a model for producing active catalysts via mixed metal oxides. Methods for successfully testing dispersed iron catalysts with the low-severity intermediate were also devised. Catalyst recovered from the dispersed iron hydroxyoxide-catalyzed reaction of ion-exchanged Wyodak gave a high conversion (47%) of LSW to heptane solubles.

28600 (DOE/PC/90048–T6) **Fine particle clay catalysts for coal liquefaction. Quarterly technical progress report, November 9, 1992–February 8, 1993.** Olson, E.S. Universal Fuel Development Associates, Inc., Grand Forks, ND (United States). [1995]. 18p. Sponsored by USDOE, Washington, DC (United States). DOE Contract AC22-91PC90048. Order Number DE96000971. Source: OSTI; NTIS; GPO Dep.

The mixed iron/alumina pillared clay catalysts and clay-supported iron catalysts have been shown in previous reports of this project to significantly improve yields of heptane-soluble products obtained in the liquefaction of both as received and acid-exchanged Wyodak subbituminous coal and Blind Canyon bituminous coal. In this quarter, the soluble product (LSW) obtained from the noncatalytic low-severity liquefaction of Wyodak coal was used as a feed to determine the activity of iron based catalysts for the hydrogenation and depolymerization steps. Comparison data for liquefaction of the soluble LSW with other catalysts were desired, and these data were obtained for a dispersed form of iron sulfide, prepared via iron hydroxyoxide (PETC method). The iron oxyhydroxide catalyst was directly precipitated on LSW product using either water or ethanol as the solvent. An insight into the functioning of the mixed iron/alumina pillared clay in coal liquefaction was investigated by preparing and studying an iron oxoaluminate structure. An investigation of new methods for the production of tetralin soluble iron oxometallate catalysts and the determination of their catalytic activities was continued in this quarter. The hydrogenation activity of iron oxoaluminate was investigated using pyrene and 1-methylnaphthalene as the test compounds, and results were compared with thermal reactions. In order to determine the loss of activity, recovered catalyst was recycled a second time for the hydrotreating of pyrene. Reaction of 1-methylnaphthalene with iron oxoaluminate also gave very high conversion to 1- and 5-methyltetralins and small amount of 2- and 6-methyltetralins. Liquefaction of Wyodak subbituminous and Blind Canyon bituminous coal was investigated using an in situ sulfided soluble iron oxoaluminate catalyst.

28601 (DOE/PC/90048–T7) **Fine particle clay catalysts for coal liquefaction. Quarterly technical progress report, May 9, 1992–August 8, 1992.** Olson, E.S. Universal Fuel Development Associates, Inc., Grand Forks, ND (United States). [1995]. 18p. Sponsored by USDOE, Washington, DC (United States). DOE Contract AC22-91PC90048. Order Number DE96000970. Source: OSTI; NTIS; GPO Dep.

An investigation of new methods for the production of mixed pillared clay catalysts and clay-supported catalysts and determination of their catalytic activities were continued in this quarter. To demonstrate the reproducibility of the preparative method for high activity iron/alumina-pillared montmorillonite catalysts, a new batch of the catalyst was prepared and tested for hydrocracking activity with bibenzyl. This preparation gave conversion and product distribution similar to that reported previously. The mixed iron/alumina-pillared clay was also prepared using a pillaring solution that was aged for longer period of time. To determine the importance of the type of pillaring support in hydrocracking activity, iron/zirconia-pillared montmorillonite was prepared using the same technique as that for iron/alumina-pillared montmorillonite. The reaction of bibenzyl with the sulfided iron/zirconia-pillared catalyst gave a lower hydrocracking conversion than the iron/alumina-pillared catalyst. Addition of a

second catalytic metal to the clay support was attempted to determine if a synergistic effect could improve liquefaction. Ferric nitrate and stannous chloride were added to the clay, but the resulting catalyst was relatively poor for hydrocracking and hydrogenation compared with ferric nitrate supported on the clay. New disposable iron catalysts with high acidity and surface area are desired for coal liquefaction. Synthetic iron aluminosilicates were prepared by methods similar to those used for the nickel-substituted synthetic mica montmorillonite (NiSMM) catalysts, which are very effective for hydrogenation and reforming of hydrocarbons. The iron aluminosilicate catalysts were tested for hydrocracking and hydrogenation of bibenzyl, naphthalene and pyrene. Pyrene hydrogenation was effectively catalyzed by the sulfided synthetic iron catalyst.

28602 (DOE/PC/90048–T8) **Fine particle clay catalysts for coal liquefaction. Quarterly technical progress report, February 9, 1992–May 8, 1992.** Olson, E.S. Universal Fuel Development Associates, Inc., Grand Forks, ND (United States). [1995]. 21p. Sponsored by USDOE, Washington, DC (United States). DOE Contract AC22-91PC90048. Order Number DE96000969. Source: OSTI; NTIS; GPO Dep.

An investigation of new methods for the production of iron-pillared clay catalysts and clay-supported iron hydroxyoxide catalysts and the determination of their catalytic activities was continued in this quarter. Previous work in this project showed that a catalyst prepared by adding ferric nitrate and ammonia to an acid-washed clay gave an active catalyst following sulfidation. Further testing of this catalyst with a model compound showed that its hydrocracking activity was considerably lower when used in 10% concentration rather than 50%. In contrast, the mixed iron/alumina pillared clay catalysts were still highly effective at 10% concentration and gave good conversions at one and two hour reaction times. An investigation of preparation methods demonstrated that calcination of both the iron hydroxyoxide-impregnated clay and the mixed iron/alumina pillared clays is essential for activity. High activity was obtained for these catalysts only when they were removed from the aqueous media rapidly, dried, and calcined. The use of ferric sulfate to prepare a clay-supported sulfated iron catalyst was attempted, the resulting catalyst was relatively inactive for hydrocracking. Several new catalysts were synthesized with the idea of decreasing the pillar density and thereby increasing the micropore volume. A zirconia-pillared clay with low pillar density was prepared and intercalated with triiron complex. The hydrocracking activity of this catalyst was somewhat lower than that of the mixed alumina/iron-pillared catalyst. Other new catalysts, that were prepared by first pillaring with an organic ammonium pillaring agent, then introducing a lower number of silica or alumina pillars, and finally the iron component, were also tested. The mixed alumina/iron-pillared catalysts was further tested at low concentration for pyrene hydrogenating and hydrocracking activities.

28603 (DOE/PC/90048–T9) **Fine particle clay catalysts for coal liquefaction. Quarterly technical progress report, November 9, 1991–February 8, 1992.** Olson, E.S. Universal Fuel Development Associates, Inc., Grand Forks, ND (United States). [1995]. 18p. Sponsored by USDOE, Washington, DC (United States). DOE Contract AC22-91PC90048. Order Number DE96000968. Source: OSTI; NTIS; GPO Dep.

The investigation of methods for the production and testing of iron-pillared clay catalysts was continued in this quarter. The surface area of the mixed alumina/iron pillared clay catalyst decreased to 51 m^2/g on sulfidation. Thus the stability of the alumina pillars during the sulfidation and thermal treatments prevented the total collapse that occurred in the case of the iron-pillared clays. Previously the mixed alumina/iron pillared clays were tested for hydrocracking activities with bibenzyl. This testing was extended to a determination of activity with a second model compound substrate (pyrene), representative of the polynuclear aromatic systems present in coal. Testing of the mixed alumina/iron-pillared catalysts with 1-methylnaphthalene gave interesting results that demonstrate shape selectivity. The clay-supported iron hydroxyoxide catalysts prepared by impregnation of iron species on acidic clays were further investigated. Sulfidation of these catalysts using the carbon disulfide in situ method gave hydrocracking activities with bibenzyl that were somewhat less than those obtained by presulfidation with H_2/H_2S mixtures. Liquefaction of Wyodak subbituminous coal was very successful with the iron impregnated clay catalyst, giving a highly soluble product. High conversions were also obtained with the mixed alumina/iron-pillared clay catalyst, but the yield of oil-solubles was considerably lower. Several new catalysts were synthesized with the idea of decreasing the pillar density and thereby increasing the micropore volume. These catalysts were prepared by first pillaring with an organic ammonium pillaring agent, then introducing a lower number of silica or alumina pillars. Finally the iron component was added either before or after thermal removal of organic pillars.

28604 (DOE/PC/90048–T10) **Fine particle clay catalysts for coal liquefaction. Final technical report.** Olson, E.S. Universal Fuel Development Associates, Inc., Grand Forks, ND (United States). Aug 1995. 26p. Sponsored by USDOE, Washington, DC (United States). DOE Contract AC22-91PC90048. Order Number DE96000965. Source: OSTI; NTIS; GPO Dep.

In an effort to develop new disposable catalysts for direct coal liquefaction, several types of clay-supported pyrrhotite catalysts were prepared and tested. These included iron-pillared montmorillonite, mixed iron/alumina-pillared montmorillonite, iron-impregnated montmorillonite, and iron oxometallate-impregnated montmorillonite.

28605 (DOE/PC/90291–T13) **Design of a high activity and selectivity alcohol catalyst. Final status report and summary of accomplishments.** Foley, H.C.; Mills, G.A. Delaware Univ., Newark, DE (United States). 15 Jul 1994. 88p. Sponsored by USDOE, Washington, DC (United States). DOE Contract FG22-90PC90291. Order Number DE95017768. Source: OSTI; NTIS; GPO Dep.

This final DOE report for grant award number DE-FG22-90PC 90291 presents the results of our efforts to better understand the Rh-Mo/γ-Al_2O3 catalytic system for the hydrogenation of carbon monoxide and carbon dioxide to selectively form oxygenated products. The content of this report is divided into three major sections and a fourth, concluding section which addresses our major research accomplishments, as well as documents the most significant publications and presentations associated with this grant. The three main sections which make up the body of this report are presented in the in form of manuscripts which, in turn, summarize our progress in three areas of this project. The three body sections are organized as follows: Section I–Evidence for site isolation in Rh-Mo bimetallic catalysts derived from organometallic clusters; Section II–Surface Chemistry of Rh-Mo/γ-Al_2O_3: An analysis of surface acidity; and Section III–Comparative study of Rh/Al_2O_3 and $Rh\text{-}Mo/Al_2O_3$ Catalysts. Section IV summarizes major accomplishments. The content of this final report is meant to generally highlight our progress in both characterizing the nature of the $Rh\text{-}Mo/Al_2O_3$ system and probing its reactivity for insight on the oxygenate synergy present in this class of catalysts.

28606 (DOE/PC/91056–T9) **Molecular catalytic coal liquid conversion. Quarterly report, [October–December 1994].** Stock, L.M.; Yang, Shiyong. Chicago Univ., IL (United States). Dept. of Chemistry. 31 Dec 1994. 16p. Sponsored by USDOE, Washington, DC (United States). DOE Contract AC22-91PC91056. Order Number DE95017751. Source: OSTI; NTIS; GPO Dep.

In this Quarter, the research was focused on the two general tasks: Task 1, molecular organometallic catalysts and the Task 2, organic base-catalyzed arene hydrogenation and hydrotreating of the coal liquids. With regards to Task 1, a biphase catalyst system, [1.5-HDRhC1]2/Buffer, was investigated for the hydrogenation of tetralin to decalin under the condition of atmosphere H2 and room temperature. The primary results indicate that tetralin was hydrogenated to decalin in more that 91% yield when only 0.5 mole% of catalyst was used. The major product was trans decalin and the cis/trans isomer ratio is 4-6: 1. The reaction was influenced by variety of the reaction conditions such as solvents used, the organic phase/aqueous phase ratio, etc. Task 2 was focused on the Catalyst 2-catalyst hydrogenation of other polycondensed aromatic hydrocarbons and on the hydrotreating of the coal liquids catalyzed by Catalyst 2 system under the similar conditions. Besides naphthalene as described in the last Quarter's report, other polycondensed aromatic hydrocarbons such as anthracene, acridine as well as 1-methoxynaphthalene were hydrogenated in good yields.

Coal liquids can be hydrogenated catalyzed by Catalyst 2 include monocyclic aromatic hydrocarbons.

28607 (DOE/PC/91056–T10) **Molecular catalytic coal liquid conversion. Quarterly report.** Stock, L.M.; Yang, Shiyong. Chicago Univ., IL (United States). Dept. of Chemistry. 31 Mar 1995. 14p. Sponsored by USDOE, Washington, DC (United States). DOE Contract AC22-91PC91056. Order Number DE95017752. Source: OSTI; NTIS; GPO Dep.

In this Quarter, the research was focused continually on the two general tasks: Task 1, molecular organometallic catalysts for hydrogenation and Task 2, organic base catalysts for arene hydrogenation and the hydrotreating of the coal liquids. With regards to Task 1, the biphase catalyst system, $[1,5\text{-HDRhCl}]_2$/buffer, was investigated in detail for the hydrogenation of naphthalene or tetralin to decalin under low pressure of H_2 at room temperature. The influence of various factors such as the amount of the phase transfer regent, the volume ratio of the organic phase to the aqueous phase, the pH value and compositions of the buffer solution as well as the solvents on the reaction process was investigated systematically. It was found that the rhodium catalyst works well under biphase conditions rather than under phase transfer conditions. Apparently, the surfactant molecules negatively affect the catalytic activity of the rhodium catalyst. The pH values and the compositions of the buffers in the aqueous phase are critical in the system. The best buffer solution is composed of hydrion with its pH of 7.4–7.6. In addition to tetralin, the Rh catalyst is also effective for the hydrogenation of other unactivated aromatic hydrocarbons such as toluene, n-butylbenzene etc. In addition, the turnover numbers of the catalyst can reach 200, but its performance needs to be improved further for practical applications. The work on this issue is currently underway. Task 2 was focused on the hydrotreating of coal liquid (VSOH) catalyzed by Catalyst 2 and Catalyst 5. Good results were achieved on this issue. Catalyst 5 was found to be a more effective catalyst for the hydrotreating of coal liquid than Catalyst 2. The coal liquid was hydrotreated to give a clear yellow liquid under relative mild conditions (1000 psi of hydrogen and 200C) if only 16 mol% of the Catalyst 5 was employed.

28608 (DOE/PC/91257–T21) **MCL (Gravimelt) System Integration Project. Quarterly report, January–March 1988.** TRW, Inc., Redondo Beach, CA (United States). 15 Apr 1988. 5p. Sponsored by USDOE, Washington, DC (United States). DOE Contract AC22-86PC91257. Order Number DE95017783. Source: OSTI; NTIS; GPO Dep.

The objective of this project is to construct and operate an integrated test circuit for the Molten-Caustic-Leaching (Gravimelt) process for, desulfurization and demineralization of coal. The test circuit consists of six unit operations which together provide a continuous system for leaching coal and regenerating the reactant. These units are: (a) a kiln for reacting molten caustic with coal; (b) a seven stage water washing section for recovering caustic from the coal; (c) a three-stage acid washing section for removing the last traces of metals and alkali and providing an ultra pure coal product; (d) a water treatment section to provide either dischargeable or recyclable water; (e) a regeneration section to provide purified aqueous caustic; and (f) an evaporator section to provide molten-caustic for recycle to the kiln reactor. The integrated test circuit facility will contain more than 160 pieces of equipment including filters, centrifuges, tanks, reactors, feeders and the kiln and rising film evaporator. It occupies 3700 square feet and will be fitted with 5800 feet of piping, 425 valves, 88 instruments and controls as well as a control, room with computer control and data acquisition and reduction system. The progress to date Is as follows: (a) 95% of the equipment has been structurally installed with the exception of the rising film evaporator package unit which is in the final stages of construction by the subcontractor; (b) approximately 70% (4000 feet) of pipe and 70% (300) valves have been installed; (c) all 88 instruments and controls have been ordered, 30 have been delivered and 16 installed; (d) the computer control and data acquisition and reduction system is on order for delivery in April.

28609 (DOE/PC/91257–T23) **MCL (Gravimelt) System Integration Project. Quarterly report, October–December 1988.** TRW, Inc., Redondo Beach, CA (United States). 15 Jan 1989. 5p. Sponsored by USDOE, Washington, DC (United States). DOE Contract AC22-86PC91257. Order Number DE95017785. Source: OSTI; NTIS; GPO Dep.

The objective of this project is to construct and operate an integrated test circuit for the Molten-Caustic-Leaching (Gravimelt) process for desulfurization and demineralization of coal to prove process economics assumptions, deliver product coal and to test process conditions aimed at significantly lowering costs. The test circuit consists of six unit operations which together provide a continuous system for leaching coal and regenerating the reactant. These units are: (a) a kiln for reacting molten caustic with coal; (b) a seven stage water washing section for recovering caustic from the coal; (c) a three-stage acid washing section for removing the last traces of metals and alkali and providing an ultra pure coal product; (d) a water treatment section to provide either dischargeable or recyclable water; (e) a regeneration section to provide purified aqueous caustic; and (f) an evaporator section to provide molten-caustic for recycle to the kiln reactor. The integrated test circuit facility contains more than 160 pieces of equipment including filters, centrifuges, tanks, reactors, feeders and the kiln and rising film evaporator. It occupies 3700 square feet and is fitted with more than 6000 feet of piping, 425 valves, 80 instruments and controls as well as a control room with computer control and data acquisition and reduction system. The highlight of the quarter is completion of a week of around-the-clock shakedown of the integrated test circuit.

28610 (DOE/PC/91257–T24) **Gravimelt Process (Molten-Caustic-Leaching). Quarterly report, January–March 1989.** TRW, Inc., Redondo Beach, CA (United States). Applied Technology Div. 14 Apr 1989. 8p. Sponsored by USDOE, Washington, DC (United States). DOE Contract AC22-86PC91257. Order Number DE95017786. Source: OSTI; NTIS; GPO Dep.

The objective of this project is to construct and operate an integrated test circuit for the Molten-Caustic-Leaching (Gravimelt) process for desulfurization and demineralization of coal to prove process economics assumptions, deliver product coal and to test process conditions aimed at significantly lowering costs. The test circuit consists of six unit operations which together provide a continuous system for leaching coal and regenerating the reactant. These units are: (a) a kiln for reacting molten caustic with coal; (b) a seven stage water washing section for recovering caustic from the coal; (c) a three-stage acid washing section for removing the last traces of metals and alkali and providing an ultra pure coal product; (d) a water treatment section to provide either dischargeable or recyclable water; (e) a regeneration section to provide purified aqueous caustic; and (f) an evaporator section to provide molten-caustic for recycle to the kiln reactor. The integrated test circuit facility contains more than 160 pieces of equipment Including filters, centrifuges, tanks, reactors, feeders and the kiln and rising film evaporator. It occupies 3700 square fast and is fitted with more than 6000 foot of piping, 425 valves, 80 instruments and controls as well as a control room with computer control and data acquisition and reduction system. The highlight of last quarter was completion of a week of around-the-clock shakedown of the integrated test circuit. This quarter, the test circuit was put into operation and compliance coal was produced.

28611 (DOE/PC/91257–T26) **Molten-Caustic-Leaching (Gravimelt) System Integration Project. Quarterly report, July–September 1989.** TRW, Inc., Redondo Beach, CA (United States). Applied Technology Div. 10 Oct 1989. 14p. Sponsored by USDOE, Washington, DC (United States). DOE Contract AC22-86PC91257. Order Number DE95017788. Source: OSTI; NTIS; GPO Dep.

Operation of the Gravimelt Integrated Test Circuit for desulfurization and demineralization of coal has been completed. A 48-test process matrix was performed over 750 hours of operational time resulting in production of 3,000 pounds of treated coal suitable for further test and evaluation. Analysis of the several thousand data is underway. Assessment of coal material balance data shows an average 98% closure with 2% conversion of coal to humics and phenolics, 3% conversion to hydrogen and methane and 3 1/2% loss as carbonate. Assessment of sulfur forms data shows a mean residual pyritic sulfur of 0.022% for Pittsburgh No. 8 seam coal and 0.01% for Kentucky No. 9. Organic sulfur removal was dependent on conditions with lowest at 0.08% after processing in the plant.

The mean sulfate sulfur level was 0.28% with a standard deviation of only 0.06%.

28612 (DOE/PC/91300–T13) **Thermodynamic and rheological properties of solid-liquid systems in coal processing. Quarterly technical report, October 1–December 31, 1994.** Kabadi, V.N.; Ilias, S. North Carolina Agricultural and Technical State Univ., Greensboro, NC (United States). Dept. of Chemical Engineering. [1995]. 20p. Sponsored by USDOE, Washington, DC (United States). DOE Contract FG22-91PC91300. Order Number DE96000923. Source: OSTI; NTIS; GPO Dep.

The objective of this project is to develop a model for solid-liquid equilibria and a model for viscosities of the products of coal liquefaction processes. The same characterization procedure and representation by continuous distributions as used in previous work on vapor-liquid equilibria and excess enthalpies of coal liquids will be used. Models when fully developed will give the solid-liquid phase equilibrium properties and viscosities as factors of temperature and pressure for known molecular weight distribution and structural characterization of the coal liquid. To accomplish this well, the project requires three tasks: (1) Solid-Liquid phase equilibrium model development; (2) Experimental Viscosity Measurements; and (3) Viscosity Model Development. The work on development of a predictive model for saturated liquid volumes of coal model compounds has been completed. A manuscript has been prepared for submission to AIChE Journal. A copy of the manuscript is attached. Work on extending the viscosity model to coal derived liquids is continuing and progress on this work will be included in the next report.

28613 (DOE/PC/91300–T14) **Thermodynamic and rheological properties of solid-liquid systems in coal processing.** Kabadi, V.N. North Carolina Agricultural and Technical State Univ., Greensboro, NC (United States). Dept. of Chemical Engineering. 30 Jun 1995. 4p. Sponsored by USDOE, Washington, DC (United States). DOE Contract FG22-91PC91300. Order Number DE96000924. Source: OSTI; NTIS; GPO Dep.

The objective of this project is to develop a model for solid-liquid equilibria and a model for viscosities of the products of coal liquefaction processes. The same characterization procedure and representation by continuous distributions as used in previous work on vapor-liquid equilibria and excess enthalpies of coal liquids will be used. Models when fully developed win give the solid-liquid phase equilibrium properties and viscosities as factors of temperature and pressure for known molecular weight distribution and structural characterization of the coal liquid. To accomplish this well, the project requires three tasks: (1) Solid-Liquid phase equilibrium model development; (2) Experimental Viscosity Measurements; and (3) Viscosity Model Development. A model for viscosity computation of coal model compound liquids and coal derived liquids has been developed. Literature review for this work included compilation of a number of data sets, critical investigation of data measurement techniques available in the literature, and investigation of models for liquid and solid phase thermodynamic computations. During the preliminary stages it was discovered that for development of a liquid or solid state equation of state, accurate predictive models for a number of saturation properties, such as, liquid and solid vapor pressures, saturated liquid and solid volumes, heat capacities of liquids and solids at saturation, etc. Most of the remaining time on this task was spent in developing predictive correlations for vapor pressures and saturated liquid volumes of organic liquids in general and coal model liquids in particular.

28614 (DOE/PC/91307–T14) **Coal combustion: Effect of process conditions on char reactivity. Quarterly technical report, October 1, 1994–December 31, 1994.** Zygourakis, K. Rice Univ., Houston, TX (United States). Dept. of Chemical Engineering. [1994]. 17p. Sponsored by USDOE, Washington, DC (United States). DOE Contract FG22-91PC91307. Order Number DE95017747. Source: OSTI; NTIS; GPO Dep.

The project will quantify the effect of the following pyrolysis conditions on the macropore structure and on the subsequent reactivity of chars: (a) pyrolysis heating rate; (b) final heat treatment temperature (HTT); (c) duration of heat treatment at HTT (or soak time); (d) pyrolysis atmosphere (N_2 or O_2/N_2 mixtures); (e) coal particle size (100–1000 μm in diameter); (f) sulfur-capturing additives (limestone); and (g) coal rank. Pyrolysis experiments will be carried out for three coals from the Argonne collection: (1) a high-volatile bituminous coal with high ash content (Illinois No. 6), (2) a bituminous coal with low ash content (Utah Blind Canyon) and (3) a lower rank subbituminous coal (Wyodak-Anderson seam). A systematic parametric study was carried out in the past quarter to quantify the effect of different process parameters on the ignition phenomena. Using the mathematical model presented in the previous quarterly report, we investigated how char properties (porosity, particle size, macropore surface area, and micropore radius) and operating conditions (oxygen concentration, flow rate) affect ignition phenomena. In every case, we clearly identified the temperature range in which thermal ignitions may be expected. Model predictions will next be compared to experimental results to validate our theoretical model.

28615 (DOE/PC/91307–T15) **Coal combustion: Effect of process conditions on char reactivity. Quarterly technical report No. 14, January 1, 1995–March 31, 1995.** Zygourakis, K. Rice Univ., Houston, TX (United States). Dept. of Chemical Engineering. [1995]. 17p. Sponsored by USDOE, Washington, DC (United States). DOE Contract FG22-91PC91307. Order Number DE95017748. Source: OSTI; NTIS; GPO Dep.

The project will quantify the effect of the following pyrolysis conditions on the macropore structure and on the subsequent reactivity of chars: (a) pyrolysis heating rate; (b) final heat treatment temperature; (c) duration of heat treatment at HTT (or soak time); (d) pyrolysis atmosphere (N_2 or O_2/N_2 mixtures); (e) coal particle size (100–1,000 μm in diameter); (f) sulfur-capturing additives (limestone); and (g) coal rank. Pyrolysis experiments will be carried out for three coals from the Argonne collection: (1) a high-volatile bituminous coal with high ash content (Illinois No. 6), (2) a bituminous coal with low ash content (Utah Blind Canyon) and (3) a lower rank subbituminous coal (Wyodak-Anderson seam). A systematic study was carried out in the past quarter to validate the mathematical model for ignition phenomena presented in the previous quarterly report. Model predictions of the effect of pyrolysis heating rate, particle size, and oxygen concentration on ignition behavior are in excellent agreement with experimental results. Moreover, our results show that the model can be used to estimate the particle temperature during ignition and the minimum ignition temperature for various process conditions.

28616 (DOE/PC/92108–T10) **Technology development for cobalt F-T catalysts. Quarterly technical progress report number 10, January 1–March 31, 1995.** Singleton, A.H. Energy International Corp., Pittsburgh, PA (United States). 28 Jun 1995. 234p. Sponsored by USDOE, Washington, DC (United States). DOE Contract AC22-92PC92108. Order Number DE96000868. Source: OSTI; NTIS; GPO Dep.

The goal of this project is the development of a commercially-viable, cobalt-based Fischer-Tropsch (F-T) catalyst for use in a slurry bubble column reactor. The major objectives of this work are (1) to develop a cobalt-based F-T catalyst with low (< 5%) methane selectivity, (2) to develop a cobalt-based F-T catalyst with water-gas shift activity, and (3) to combine both these improvements into one catalyst. The project consists of five major tasks: catalyst development; catalyst testing; catalyst reproducibility tests; catalyst aging tests; and preliminary design and cost estimate for a demonstrate scale catalyst production facility. Technical accomplishments during this reporting period include the following. It appears that the higher activity obtained for the catalysts prepared using an organic solution and reduced directly without prior calcination was the result of higher dispersions obtained under such pretreatment. A Ru-promoted Co catalyst on alumina with 30% Co loading exhibited a 4-fold increase in dispersion and a 2-fold increase in activity in the fixed-bed reactor from that obtained with the non-promoted catalyst. Several reactor runs have again focused on pushing conversion to higher levels. The maximum conversion obtained has been 49.7% with 26g catalyst. Further investigations of the effect of reaction temperature on the performance of Co catalysts during F-T synthesis were started using a low activity catalyst and one of the most active catalysts. The three 1 kg catalyst batches prepared by Calsicat for the reproducibility

and aging studies were tested in both the fixed-bed and slurry bubble column reactors under the standard reaction conditions. The effects of adding various promoters to some cobalt catalysts have also been addressed. Results are presented and discussed.

28617 (DOE/PC/92122–T10) **Novel bimetallic dispersed catalysts for temperature-programmed coal liquefaction. Technical progress report, January–March, 1995.** Song, C.; Kirby, S. Schmidt, E.; Schobert, H.H. Pennsylvania State Univ., University Park, PA (United States). Dept. of Materials Science and Engineering. May 1995. 18p. Sponsored by USDOE, Washington, DC (United States). DOE Contract AC22-92PC92122. Order Number DE96000926. Source: OSTI; NTIS; GPO Dep.

Coal liquefaction involves cleavage of methylene, dimethylene and ether bridges connecting polycyclic aromatic units and the reactions of various oxygen functional groups. The selected compound for model coal liquefaction reactions are 4-(1-naphthylmethyl)bibenzyl (NMBB) and anthrone. This report describes hydrodeoxygenation of O-containing polycyclic model compounds using novel organometallic catalyst precursors and activity and selectivity of dispersed Fe catalysts from organometallic and inorganic precursors for hydrocracking of 4-(1-Naphthylmethyl) bibenzyl. For hydrodeoxygenation, model compound studies were performed using multi-ring systems, or those of comparable molecular weight, to investigate the capabilities of the dispersed catalysts. The model compounds selected include anthrone (carbonyl); dinaphthyl ether (aryl-aryl ether); xanthene (heterocyclic ether); and 2,6-di-t-butyl-4-methylphenol (hydroxyl). The catalyst precursors used were $(NH_4)_2MoS_4$, $[Ph_4P]_2[Ni(MoS_4)_2]$ and $Cp_2Co_2Mo_2(CO)_2S_4$. To examine what determines the activity and selectivity of Fe catalysts for hydrogenation and hydrocracking, various molecular precursors with Fe in different chemical environments have been tested in this work to help understand the influence of precursor structure and the effect of sulfur addition on the activity and selectivity of resulting Fe catalysts in model reactions of 4-(naphthylmethyl)bibenzyl. The authors have examined various precursors, including a thiocubane type cluster $Cp_4Fe_4S_4$, a cyclopentadienyliron dicarbonyl dimer $Cp_2Fe_2(CO)_4$, ferrocene Cp_2Fe, a series of carbonyl precursors including $Fe(CO)_5$, $Fe_2(CO)_9$, and $Fe_3(CO)_{12}$, and superfine iron oxide with average particle size of 30 Å.

28618 (DOE/PC/92147–10) **Catalytic multi-stage liquefaction of coal. Tenth quarterly report, January 1–March 31, 1995.** Comolli, A.G.; Johanson, E.S.; Lee, L.K.; Pradhan, V.R.; Stalzer, R.H. Hydrocarbon Technologies, Inc., Lawrenceville, NJ (United States). May 1995. 19p. Sponsored by USDOE, Washington, DC (United States). DOE Contract AC22-93PC92147. Order Number DE96000904. Source: OSTI; NTIS; GPO Dep.

The overall objective of this program is to produce liquid fuels from coal by direct liquefaction at a cost that is competitive with conventional fuels. Specifically, this continuous bench-scale program contains provisions to examine new ideas in areas such as: low temperature pretreatments, more effective catalysts, on-line hydrotreating, new coal feedstocks, other hydrogen sources, more concentrated coal feeds and other highly responsive process improvements while assessing the design and economics of the bench-scale results. This report describes the following: (1) laboratory support for bench run CMSL-09, (2) the laboratory-scale efforts for development of suitable catalysts for hydrocracking/depolymerization of waste plastics, (3) analysis of TBP (true boiling point) fractions of distillates from CMSL-08, and (4) objectives and run-plan for bench run CMSL-09.

28619 (DOE/PC/93066–T1) **Moessbauer spectroscopy studies of iron-catalysts used in Fischer-Tropsch (FT) processes. Quarterly technical progress report, January–March, 1994.** Huffman, G.P.; Rao, K.R.P.M. Kentucky Univ., Lexington, KY (United States). [1994]. 25p. Sponsored by USDOE, Washington, DC (United States). DOE Contract AC22-94PC93066. Order Number DE96000911. Source: OSTI; NTIS; GPO Dep.

The objective of this project is to carry out a Moessbauer spectroscopy study of Iron-based catalysts to identify iron phases present and correlate with water gas shift and FT activities. A total of 15 catalysts were evaluated so far. Results are presented on the amounts in each catalyst of the following phases: superparamagnetic phase, hematite (α-Fe_2O_3), magnetite (Fe_3O_4), Chi-carbide phase (χ-Fe_5C_2), and an epsilon-carbide phase (ε-$Fe_{2.2}C$).

28620 (DOE/PC/93066–T2) **Moessbauer spectroscopy studies of iron-catalysts used in Fischer-Tropsch (FT) processes. Quarterly technical progress report, April–June, 1994.** Huffman, G.P.; Rao, K.R.P.M. Kentucky Univ., Lexington, KY (United States). [1994]. 5p. Sponsored by USDOE, Washington, DC (United States). DOE Contract AC22-94PC93066. Order Number DE96000912. Source: OSTI; NTIS; GPO Dep.

Moessbauer spectroscopy investigations were carried out on 16 iron-based catalysts during the period under review. A set of 10 samples subjected to different pretreatments and Fischer-Tropsch synthesis were investigated to understand the effect of reduction in different gas atmospheres on the iron phases formed. Another set of 5 catalysts pretreated in CO and subjected to Fischer-Tropsch synthesis using two kinds of wax viz., (a) a low molecular wt. wax and (b) heavy wax were also studied. Although it is difficult to draw any definite conclusions from the data, some plausible trends are noticed: (1) pretreatment of a catalyst in H_2 leads to the formation of ε-carbide; (2) pretreatment of a catalyst in H_2/CO leads to the formation of χ-carbide; (3) reduction of UCI-1185-149-2ND catalyst in CO leads to the formation of χ-carbide; and (4) reduction of DOE catalysts in CO leads to the formation of ε-carbide. Data are presented on the phases found in the various catalysts.

28621 (DOE/PC/93066–T3) **Moessbauer spectroscopy studies of iron-catalysts used in Fischer-Tropsch (FT) processes. Quarterly technical progress report, July–September, 1994.** Huffman, G.P.; Rao, K.R.P.M. Kentucky Univ., Lexington, KY (United States). [1994]. 5p. Sponsored by USDOE, Washington, DC (United States). DOE Contract AC22-94PC93066. Order Number DE96000913. Source: OSTI; NTIS; GPO Dep.

Moessbauer spectroscopy investigations were carried out on 7 iron-based catalysts during the period under review. A set of four samples subjected to activation in syn gas and Fischer-Tropsch synthesis were sent by R.J. Gormley, to understand the behavior of the low alpha catalyst used in these runs. Another three used catalyst samples extracted from the LaPorte Run II were sent By Dr. Bharat Bhatt to understand the phase distribution and any correlation with the run results. The high alpha UCI catalyst used in the LaPorte Run I was studied to compare with the UCI low alpha catalyst used in LaPorte Run II. All together 10 Moessbauer measurements both at room and low temperatures were carried out to identify the iron phases present in these catalyst samples. Results to date are presented and some plausible trends are outlined.

28622 (DOE/PC/93066–T4) **Moessbauer spectroscopy studies of iron-catalysts used in Fischer-Tropsch (FT) processes. Quarterly technical progress report, October–December, 1994.** Huffman, G.P.; Rao, K.R.P.M. Kentucky Univ., Lexington, KY (United States). [1994]. 11p. Sponsored by USDOE, Washington, DC (United States). DOE Contract AC22-94PC93066. Order Number DE96000914. Source: OSTI; NTIS; GPO Dep.

Moessbauer spectroscopy investigations on 6 iron-based catalysts and analysis of the XAFS measurements done earlier on 23 catalysts , were carried out during the period under review. A set of 4 catalysts subjected to CO pretreatment and Fischer-Tropsch synthesis were sent by Robert J. Gormley, PETC, Dept. of Energy, to understand the effect of reduction on the iron phases formed. A catalyst activated in CO and subjected to Fischer-Tropsch synthesis and extracted directly into an "O" ring sealed Moessbauer absorber holder under argon atmosphere and another catalyst from the same run but exposed to air were sent by Dr. Burt Davis, CAER, Univ. of Kentucky, for identifying the iron phases present and to monitor the differences, if any, between two catalysts. Results to date are presented.

28623 (DOE/PC/93066–T5) **Moessbauer spectroscopy studies of iron-catalysts used in Fischer-Tropsch (FT) processes. Quarterly technical progress report, January–March, 1995.** Huffman, G.P.; Rao, K.R.P.M. Kentucky Univ., Lexington, KY (United States). [1995]. 5p. Sponsored by USDOE, Washington, DC (United States). DOE Contract AC22-94PC93066. Order Number DE96000915. Source: OSTI; NTIS; GPO Dep.

Moessbauer spectroscopy investigations were carried out on 14 iron-based catalysts during the period under review. The catalyst 100Fe/4.4Si/0.71K (all atomic ratios) was subjected to activation first in syngas and subsequently in CO gas atmosphere. Fischer-Tropsch (FT) synthesis was carried out on the above catalyst. Another catalyst 100Fe/4.4Si/2.6Cu/0.71K (all atomic ratios) activated in syngas and subjected to FT synthesis was also studied to understand the effect of added Cu on the phase distribution and its effect on the FT activity. The following trends were observed: (1) activation of the catalyst in syngas, H_2/CO, lead to the formation of Fe_3O_4 and no carbides were formed, the FT activity was found to be low at 9–12% (H_2+CO) conversion; (2) activation of the catalyst in CO for 22hrs lead to the formation of 33% of χ-carbide and the FT activity was found to be high at 88% maximum; (3) addition of copper to the catalyst has improved the FT activity for those catalysts pretreated in syngas at elevated pressures.

28624 (DOE/PC/94055–T2) **Technology development for iron Fischer-Tropsch catalysis. Quarterly technical progress report No. 2, January 1, 1995–March 31, 1995.** Davis, B.H. Kentucky Univ., Lexington, KY (United States). Research Foundation. 2 May 1995. 51p. Sponsored by USDOE, Washington, DC (United States). DOE Contract AC22-94PC94055. Order Number DE95016281. Source: OSTI; NTIS; GPO Dep.

The Fischer-Tropsch synthesis has been studied over the best low-alpha catalyst developed at the CAER. A wide range of synthesis gas conversions were obtained by varying the space velocity. The experimental results show that: (1) the rate of the water gas shift reaction is lower than the rate of the Fischer-Tropsch reaction at low conversions (< 60%) whereas it closely approaches the rate of the Fischer-Tropsch synthesis at high conversions, (2) the fraction of CO converted to hydrocarbons is higher at low and intermediate conversions whereas it is smaller at high conversions, (3) the H_2/CO ratio of the product gas is equal to the H_2/CO ratio of the inlet synthesis gas at an intermediate conversion level of 67%. These findings suggest that it would be beneficial to carry out the reaction at intermediate conversions. This would result in an optimum use of CO to produce hydrocarbons rather than CO_2. High overall conversions can be obtained by either using a second reactor or recycling the product gas using a single reactor. If the intermediate conversion in a single pass is maintained at 67% there would be no need to adjust the H_2/CO ratio of the recycle stream or the feed to the second reactor as the product gas from a single pass would have the same H_2/CO ratio as the feed synthesis gas. The optimum reaction rate expression for synthesis gas conversion which has been developed for this catalyst shows that CO is strongly adsorbed on the catalyst and that the reaction products such as water and CO_2 do not inhibit the reaction rate.

28625 (DOE/PC/94065–T2) **Synthesis of acrylates and methacrlyates from coal-derived syngas. Quarterly technical progress report, January 1, 1995–March 31, 1995.** Tischer, R.E.; Spivey, J.J. Research Triangle Inst., Research Triangle Park, NC (United States). [1995]. 12p. Sponsored by USDOE, Washington, DC (United States). DOE Contract AC22-94PC94065. Order Number DE95015914. Source: OSTI; NTIS; GPO Dep.

The objective Task 1, Synthesis of Propionates, is to develop the technology for the synthesis of low-cost propionates. These propionates are the basic feedstock for the subsequent reaction with formaldehyde to produce the target molecule, methyl methacrylate (MMA). Eastman has explored several possible routes to the propionates and has concluded that the most promising is the synthesis of propionic anhydride from the reaction of propionic acid from and ethylene (and also hydrogen in some cases). The main advantage of the anhydride over the acid is that its subsequent reaction with formaldehyde does not produce water, which can lead to undesired byproducts. Bechtel is carrying out a cost analysis of the Eastman route to the anhydride to determine if it is potentially competitive with commercially practiced routes to the same molecule. The answer is expected next quarter. The objective Task 2, Condensation Catalysis to develop catalysts for the condensation of the propionate (propionic anhydride is our target molecule) with formaldehyde. This reaction produces methacrylic acid (MAA), which would then be reacted with methanol to produce MMA in the slurry reactor. We have synthesized a wide range of catalysts and the results show that there is substantial byproduct formation, including 3-pentanone and some propionic acid. Our results show the highest yields of MAA using an alkalized alumina ($1\%Na/_{\gamma}$-Al_2O_3). Although the condensation of propionic acid with formaldehyde is well studied in the literature, little is reported on the condensation of the anhydride. Although it is likely that the same general types of acid/base catalysts that promote the acid condensation will also promote that of the anhydride, the strength and balance of the acid and base sites is likely to be different. We plan to explore the relationship of the catalyst properties and MMA yields using the Altamira system, due to be delivered this next quarter.

28626 (DOE/PC/94207–T3) **High temperature electrochemical polishing of H_2S from coal gasification process stream. Quarterly progress report, January 1, 1995–March 31, 1995.** Winnick, J. Georgia Inst. of Tech., Atlanta, GA (United States). School of Chemical Engineering. [1995]. 19p. Sponsored by USDOE, Washington, DC (United States). DOE Contract FG22-94PC94207. Order Number DE95016270. Source: OSTI; NTIS; GPO Dep.

An advanced process for the separation of hydrogen sulfide (H_2S) from coal gasification product streams through an electrochemical membrane is being developed. H_2S is removed from the syn-gas stream, split into hydrogen, which enriches the exiting syngas, and sulfur, which is condensed from an inert sweep gas stream. The process allows removal of H_2S without cooling the gas stream and with negligible pressure loss through the separator. The process is made economically attractive by the lack of need for a Claus process for sulfur recovery. To this extent the project presents a novel concept for improving utilization of coal for more efficient power generation. Past experiments using this concept dealt with identifying removal of 1–2% H_2S from gases containing only H_2S in N_2, simulated natural gas, and simulated coal gas. Data obtained from these experiments resulted in extended studies into electrode kinetics and electrode stability in molten melts. The most recent experiments evaluated the polishing application (removal Of H_2S below 10 ppm) using the Electrochemical Membrane Separator (EMS). H_2S removal efficiencies over 90% were achieved at these stringent conditions of low H_2S concentrations proving the technologies polishing capabilities. Other goals include optimization of cell materials capable of improving cell performance. Once cell materials are defined, cell experiments determining maximum removal capabilities and current efficiencies will be conducted. Also, a model theoretically describing the preferred reduction of H_2S, the transport of S^{2-}, and the competing transport of CO_2 will be investigated. The model should identify the maximum current efficiency for H_2S removal, depending on variables such as flow rate, temperature, current application, and the total cell potential.

28627 (ETDE-DE–207) **Participation in the 2.5 t/d British Coal (BCC) liquefaction pilot plant project Point of Ayr. Final report.** Hechtfisch, J.; Dohms, K.D. Ruhrkohle AG, Essen (Germany); ROeG Umwelttechnologie GmbH, Essen (Germany). Mar 1995. 30p. (In German). Sponsored by Bundesministerium fuer Bildung, Wissenschaft, Forschung und Technologie, Bonn (Germany). Foerderkennzeichen BMBF 0326532A. Order Number DE96706600. Source: OSTI; NTIS (US Sales Only).

The object of the programme is testing and continued development of the LSE process (Liquid Solvent Extraction) in continuous and integrated operation of a pilot plant in order to provide evidence that the process is technically feasible on a commercial scale. According to the objectives of the application for subsidy the main aim of the investigations was to demonstrate that coal can be converted by hydrogenation at a high conversion ratio to yield valuable distillate products which are subsequently refined to transport fuels. An additional intent was to produce a data base for scale-up purposes. The LSE process is a two stage approach for coal hydrogenation. Its main features are extraction at a low first stage operating pressure, solids removal by filtration and subsequent hydrocracking in ebullated bed reactors. During 3 years of operation the reliability and availability of the plant and essential equipment was extended considerably by technical changes. Distillate yields of 40%, roughly, were demonstrated, lower than expected. The

issue of the pilot plant project is that the LSE technology is technically ready for commercialisation, an alteration of economic terms provided. (orig.)

28628 (IS-T–1722) **Intermolecula transfer and elimination of molecular hydrogen in thermal reactions of unsaturated organic compounds.** Suria, S. Ames Lab., IA (United States). 10 Feb 1995. 100p. Sponsored by USDOE, Washington, DC (United States). DOE Contract W-7405-ENG-82. Order Number DE96000222. Source: OSTI; NTIS; GPO Dep.

Two reactions which are important to coal liquefaction include intermolecular transfer and the elimination of two hydrogen atoms. We have designed several model reactions to probe the viability of several hydrogen transfer and elimination pathways. This report described studies on these reactions using organic model compounds.

28629 (KRC–90G-J07) **An Experimental study on the Coal Gasifier and Purification system for IGCC Plant.** Jee, P.S. (Korea Electric Power Corp. (KEPCO), Taejon (Korea, Republic of). Research Center); Ahn, D.H.; Chung, J.D.; Kim, J.J.; Kim, N.H.; Song, K.S.; Wei, Y.H.; Park, T.J.; Son, J.I.; Lee, H.J.; Lee, J.K.; Kim, J.H.; Hong, J.C.; Kim, Y.K.; Lee, B.D.; MooKorea Electric Power Corp. (KEPCO), Taejon (Korea, Republic of). Research Center. 1993. 433p. (In Korean). Order Number DE96703593. Source: OSTI; NTIS (US Sales Only).

Integrated Coal Gasification Combined Cycle(IGCC) plant is an advanced and sophisticated power generation technology, which involves the couplings of a coal gasification system with clean coal gas by desulfurization and a electric power generation system such as gas turbine and steam turbine. The IGCC system has some advantage over conventional coal combustion system for electric power. These advantage include about 10% higher energy efficiency and reduced pollutant emissions such as NO_x and SO_x. The objectives of the present study is to build a 0.5 T/D coal gasifier in form of the entrained bed so that it could understand not only the principle of the gasification, but realize the overall problems that it might have occurred. The results will contribute to give directions and suggestions for the development and adoption of a gasifier. (author). 64 refs., fig.

28630 (ORNL–6874, pp. 147-151) **Carbon formation and metal dusting in hot-gas cleanup systems of coal gasifiers.** Tortorelli, P.F. (and others); DeVan, H.J.; Judkins, R.R. Oak Ridge National Lab., TN (United States). Jun 1995. DOE Contract AC05-84OR21400. In *Fossil Energy Program annual progress report for April 1994 through March 1995.* 203p. Order Number DE95015441. Source: OSTI; NTIS; GPO Dep.

The product gas resulting from the partial oxidation of carboniferous materials in a gasifier consists predominantly of CO, CO_2, H_2, H_2O, CH_4, and, for air-blown units, N_2 in various proportions at temperatures ranging from about 400 to 1000°C. Depending on the source of the fuel, smaller concentrations of H_2S, COS, and NH_3 can also be present. The gas phase is typically characterized by high carbon and sulfur, but low oxygen, activities and, consequently, severe degradation of the structural and functional materials used in the gasifier can occur. Therefore, there are numerous concerns about materials performance in coal gasification systems, particularly at the present time when demonstration-scale projects are in or nearing the construction and operation phases. This study focused on the subset of materials degradation phenomena resulting from carbon formation and carburization processes, which are related to potential operating problems in certain gasification components and subsystems. More specifically, it examined the current state of knowledge regarding carbon deposition and a carbon-related degradation phemonenon known as metal dusting as they affect the long-term operation of the gas clean-up equipment downstream of the gasifier and addressed possible means to mitigate the degradation processes. These effects would be primarily associated with the filtering and cooling of coal-derived fuel gases from the gasifier exit temperature to as low as 400°C. However, some of the consideratins are sufficiently general to cover conditions relevant to other parts of gasification systems.

28631 (ORNL–6874, pp. 171-177) **Fundamental bioprocessing research for coal applications.** Kaufman, E.N.; Scott, T.C. Oak Ridge National Lab., TN (United States). Jun 1995. In *Fossil Energy Program annual progress report for April 1994 through March 1995.* 203p. Order Number DE95015441. Source: OSTI; NTIS; GPO Dep.

The purpose of this program is to gain a fundamental understanding and sound scientific and technical basis for evaluating the potential roles of innovative bioprocessing concepts for the utilization and conversion of coal. The aim is to explore the numerous ways in which advanced biological processes and techniques can open new opportunities for coal utilization or can replace more conventional techniques by using milder conditions with less energy consumption or loss. There are several roles where biotechnology is likely to be important in coal utilization and conversion. These include potential bioprocessing systems such as conversion of coal to liquids or gases; biocatalytic beneficiation of coal-derived liquids and conversion to useful chemical feedstocks; biocatalytic removal of SO_x and NO_x from coal combustion off-gas; environmental control technology for the removal or destruction of hazardous materials in process effluents and/or solid residues; and the removal and utilization of CO_2 from combustion off-gas. Effective bioprocesses for such applications will require detailed knowledge of the biological process mechanisms and advanced bioreactor technology than can be optimized for high productivity, as well as supporting upstream and downstream processes that will allow an effective integrated bioprocess. Of particular interest is the development of predictive models that can be used for process design and scaleup. In this program, a generic approach is taken so that there will be utility over a broad range of applications. In conjunction with the generic approach, model experimental systems that address real-world problems are used to verify the results.

28632 (ORNL–6874, pp. 179-183) **Advanced bioreactor systems for gaseous substrates: Conversion of synthesis gas to liquid fuels and removal of SO_x and NO_x from coal combustion gases.** Selvaraj, P.T.; Kaufman, E.N. Oak Ridge National Lab., TN (United States). Jun 1995. In *Fossil Energy Program annual progress report for April 1994 through March 1995.* 203p. Order Number DE95015441. Source: OSTI; NTIS; GPO Dep.

The purpose of the proposed research program is the development and demonstration of a new generation of gaseous substrate-based bioreactors for the production of liquid fuels from coal synthesis gas and the removal of NO_x and SO_x species from combustion flue gas. Coal is thermochemically converted to synthesis gas consisting of carbon monoxide, hydrogen, and carbon dioxide. Conventional catalytic upgrading of coal synthesis gas into alcohols or other oxychemicals is subject to several processing problems such as interference of the other constituents in the synthesis gases, strict CO/H_2 ratios required to maintain a particular product distribution and yield, and high processing cost due to the operation at high temperatures and pressures. Recently isolated and identified bacterial strains capable of utilizing CO as a carbon source and coverting CO and H_2 into mixed alcohols offer the potential of performing synthesis gas conversion using biocatalysts. Biocatalytic conversion, though slower than the conventional process, has several advantages such as decreased interference of the other constituents in the synthesis gases, no requirement for strict CO/H_2 ratios, and decreased capital and oeprating costs as the biocatalytic reactions occur at ambient temperatures and pressures.

28633 (ORNL–6874, pp. 187-197) **Renewable hydrogen production for fossil fuel processing.** Greenbaum, E. (and others); Lee, J.W.; Tevault, C.V. Oak Ridge National Lab., TN (United States). Jun 1995. In *Fossil Energy Program annual progress report for April 1994 through March 1995.* 203p. Order Number DE95015441. Source: OSTI; NTIS; GPO Dep.

In the fundamental biological process of photosynthesis, atmospheric carbon dioxide is reduced to carbohydrate using water as the source of electrons with simultaneous evolution of molecular oxygen: $H_2O + CO_2 + \text{light} \rightarrow O_2 + (CH_2O)$. It is well established that two light reactions, Photosystems I and II (PSI and PSII) working in series, are required to perform oxygenic photosynthesis. Experimental data supporting the two-light reaction model are based on the quantum requirement for complete photosynthesis, spectroscopy, and direct biochemical analysis. Some algae also

have the capability to evolve molecular hydrogen in a reaction energized by the light reactions of photosynthesis. This process, now known as biophotolysis, can use water as the electron donor and lead to simultaneous evolution of molecular hydrogen and oxygen. In green algae, hydrogen evolution requires prior incubation under anaerobic conditions. Atmospheric oxygen inhibits hydrogen evolution and also represses the synthesis of hydrogenase enzyme. CO_2 fixation competes with proton reduction for electrons relased from the photosystems. Interest in biophotolysis arises from both the questions that it raises concerning photosynthesis and its potential practical application as a process for converting solar energy to a non-carbon-based fuel. Prior data supported the requirement for both Photosystem I and Photosystem II in spanning the energy gap necessary for biophotolysis of water to oxygen and hydrogen. In this paper we report the at PSII alone is capable of driving sustained simultaneous photoevolution of molecular hydrogen and oxygen in an anaerobically adapted PSI-deficient strain of Chlamydomonas reinhardtii, mutant B4, and that CO_2 competes as an electron acceptor.

28634 Method for reducing sulfate formation during regeneration of hot-gas desulfurization sorbents. Bissett, L.A.; Strickland, L.D.; Rockey, J.M. 1993. Filed date 14 Jun 1993. U.S. Patent Application 8-076,060. 32p. Sponsored by USDOE, Washington, DC (United States). Order Number DE95017110. Source: OSTI; NTIS (US Sales Only); GPO Dep.

Regeneration of sulfur sorbents having sulfate forming tendencies and used for desulfurizing hot product gas streams such as provided by coal gasification is provided by employing a two-stage regeneration method. Air containing a sub-stoichiometric quantity of oxygen is used in the first stage for substantially fully regenerating the sorbent without sulfate formation and then regeneration of the resulting partially regenerated sorbent is completed in the second stage with air containing a quantity of oxygen slightly greater than the stoichiometric amount adequate to essentially fully regenerate the sorbent. Sulfate formation occurs in only the second stage with the extent of sulfate formation being limited only to the portion of the sulfur species contained by the sorbent after substantially all of the sulfur species have been removed there from in the first stage.

28635 (SAND–95-1989C) **Advanced progress concepts for direct coal liquefaction.** Anderson, R. (Univ. of Kentucky Center for Applied Energy Research, Lexington, KY (United States)); Derbyshire, F.; Givens, E. Sandia National Labs., Albuquerque, NM (United States). [1995]. 25p. Sponsored by USDOE, Washington, DC (United States). DOE Contract AC04-94AL85000. (CONF-9508133–7: Coal liquefaction and gas conversion contractor review meeting, Pittsburgh, PA (United States), 29-31 Aug 1995). Order Number DE95017892. Source: OSTI; NTIS; GPO Dep.

Given the low cost of petroleum crude, direct coal liquefaction is still not an economically viable process. The DOE objectives are to further reduce the cost of coal liquefaction to a more competitive level. In this project the primary focus is on the use of low-rank coal feedstocks. A particular strength is the use of process-derived liquids rather than model compound solvents. The original concepts are illustrated in Figure 1, where they are shown on a schematic of the Wilsonville pilot plant operation. Wilsonville operating data have been used to define a base case scenario using run #263J, and Wilsonville process materials have been used in experimental work. The CAER has investigated: low severity CO pretreatment of coal for oxygen rejection, increasing coal reactivity and mg inhibiting the propensity for regressive reactions; the application of more active. Low-cost Fe and Mo dispersed catalysts; and the possible use of fluid coking for solids rejection and to generate an overhead product for recycle. CONSOL has investigated: oil agglomeration for coal ash rejection, for the possible rejection of ash in the recycled resid, and for catalyst addition and recovery; and distillate dewaxing to remove naphthenes and paraffins, and to generate an improved quality feed for recycle distillate hydrogenation. At Sandia, research has been concerned with the production of active hydrogen donor distillate solvent fractions produced by the hydrogenation of dewaxed distillates and by fluid coking via low severity reaction with $H_2/CO/H_2O$ mixtures using hydrous metal oxide and other catalysts.

28636 (SAND–95-2181C) **Synthesis and characterization of Fe colloid catalysts in inverse micelle solutions.** Martino, A. (and others); Stoker, M.; Hicks, M. Sandia National Labs., Albuquerque, NM (United States). [1995]. 15p. Sponsored by USDOE, Washington, DC (United States). DOE Contract AC04-94AL85000. (CONF-9508133–6: Coal liquefaction and gas conversion contractor review meeting, Pittsburgh, PA (United States), 29-31 Aug 1995). Order Number DE96000786. Source: OSTI; NTIS; GPO Dep.

We have studied the formation of Fe clusters in inverse micelles. We have characterized the clusters with respect to size with transmission electron microscopy (TEM) and with respect to chemical composition with Mossbauer spectroscopy, electron diffraction, and x-ray photoelectron spectroscopy (XPS). In addition, we have tested these iron based clusters for catalytic activity in a model hydrogenolysis reaction. The formation of ultra-small metal particles is of particular interest in the area of chemical catalysis. The clusters are high surface area, highly dispersed, unsupported materials. In addition, catalytic enhancement due to unique material properties (i.e. quantum size effects) is possible. Metal clusters prepared by a number of techniques have been studied as potential catalysts. Reactant adsorption and the reactivity in various processes depends strongly on particle size. We are studying iron clusters as potential catalysts in hydrogenation reactions, Fischer-Tropsch synthesis, and coal liquefaction.

0106 Properties and Composition

Refer also to citation(s) 28579, 28580, 28582, 28585, 28589, 28612, 28613, 28671

28637 (DOE/PC/89773–T4) **Coal plasticity at high heating rates and temperatures. Final technical progress report.** Gerjarusak, S.; Peters, W.A.; Howard, J.B. Massachusetts Inst. of Tech., Cambridge, MA (United States). May 1995. 187p. Sponsored by USDOE, Washington, DC (United States). DOE Contract FG22-89PC89773. (FE-MIT–89773-FINAL). Order Number DE95017769. Source: OSTI; NTIS; GPO Dep.

Plastic coals are important feedstocks in coke manufacture, coal liquefaction, gasification, and combustion. During these processes, the thermoplastic behavior of these coals is also important since it may contribute to desirable or undesirable characteristics. For example, during liquefaction, the plastic behavior is desired since it leads to liquid-liquid reactions which are faster than solid-liquid reactions. During gasification, the elastic behavior is undesired since it leads to caking and agglomeration of coal particles which result in bed bogging in fixed or fluidized bed gasifiers. The plastic behavior of different coals was studied using a fast-response plastometer. A modified plastometer was used to measure the torque required to turn at constant angular speed a cone-shaped disk embedded in a thin layer of coal. The coal particles were packed between two metal plates which are heated electrically. Heating rates, final temperatures, pressures, and durations of experiment ranged from 200–800 K/s, 700–1300 K, vacuum-50 atm helium, and 0–40 s, respectively. The apparent viscosity of the molten coal was calculated from the measured torque using the governing equation of the cone-and-plate viscometer. Using a concentrated suspension model, the molten coal's apparent viscosity was related to the quantity of the liquid metaplast present during pyrolysis. Seven coals from Argonne National Laboratory Premium Coal Sample Bank were studied. Five bituminous coals, from high-volatile to low-volatile bituminous, were found to have very good plastic behavior. Coal type strongly affects the magnitude and duration of plasticity. Hvb coals were most plastic. Mvb and lvb coals, though the maximum plasticity and plastic period were less. Low rank coals such as subbituminous and lignite did not exhibit any plasticity in the present studies. Coal plasticity is moderately well correlated with simple indices of coal type such as the elemental C,O, and H contents.

28638 (DOE/PC/92527–T10) **Hindered diffusion of coal liquids. Quarterly report No. 10, December 18, 1994–March 17, 1995.** Tsotsis, T.T. (University of Southern California, Los Angeles, CA (United States). Dept. of Chemical Engineering); Sahimi, M.; Webster, I.A. University of Southern California, Los Angeles, CA

(United States). Dept. of Chemical Engineering. [1995]. 27p. Sponsored by USDOE, Washington, DC (United States). DOE Contract FG22-92PC92527. Order Number DE95017750. Source: OSTI; NTIS; GPO Dep.

The design of industrial catalysts requires that the diffusivity of the reacting species within the catalyst be accurately known. Nowhere is this more important than in the area of coal liquefaction and upgrading of coal liquids. In this area one is faced with the task of processing a number of heavy oils, containing metals and other contaminants, in a variety of process dependent solvents. It is important, therefore, on the basis of predicting catalyst activity, selectivity, and optimizing reactor performance, that the diffusivities of these oil species be accurately known. Throughout the experimental runs we will utilize a high pressure, high temperature diffusion of cell system. This diffusion system has been tested through the measurement of the diffusivity of a number of model coal liquids. The following were accomplished this quarter: During this quarter, we have initiated a series of transport investigations under high temperature (360°) high pressure (500 psi, H_2) reactive conditions. We have also continued our studies of formation and precipitation of fractal molecular aggregates in porous media. Small-angle scattering as well as precipitation data are analyzed to delineate the structure of the molecular colloidal aggregates that are formed, when a fluid is injected into the pore space of a porous medium to react with, or displace the in-place fluid. The results suggest that these colloidal structures are diffusion-limited particle and cluster aggregates. This is the first conclusive evidence for fractality of such molecular aggregates, which has important implications for their stability and molecular weight distribution, as well as modelling their flow and precipitation in a porous medium.

28639 (DOE/PC/92544–11) **Vapor pressures and heats of vaporization of primary coal tars. Quarterly technical progress report, 1 January 1995–31 March 1995.** Suuberg, E.M.; Oja, V.; Lilly, W.D. Brown Univ., Providence, RI (United States). Div. of Engineering. [1995]. 9p. Sponsored by USDOE, Washington, DC (United States). DOE Contract FG22-92PC92544. Order Number DE95016265. Source: OSTI; NTIS; GPO Dep.

The vapor pressure correlations that exist at present for coal tars are very crude and they are not considered reliable to even an order of magnitude when applied to tars. Sophisticated general correlative approaches are slowly being developed, based upon group contribution methods, or based upon some key functional features of the molecules. These are as yet difficult to apply to coal tars. The detailed group contribution methods, in which fairly precise structural information is needed, do not lend themselves well for application to very complex, poorly characterized coal tars. The methods based upon more global types of characterizations have not yet dealt much with the question of oxygenated functional groups. In short, only very limited correlations exist, and these are not considered reliable to even an order of magnitude when applied to tars. The present project seeks to address this important gap in the near term by direct measurement of vapor pressures of coal tar fractions, by application of well-established techniques and modifications thereof. The principal objectives of the program are to: (1) obtain data on the vapor pressures and heats of vaporization of tars from a range of ranks of coal, (2) develop correlations based on a minimum set of conveniently measurable characteristics of the tars, (3) develop equipment that would allow performing such measurements in a reliable, straightforward fashion. A significant amount of time has been devoted during this quarter to testing the equipment for measurements by the Knudsen effusion method. The basic technique was described in the 9th Quarterly Report how the performance of the apparatus was checked by measuring, as a function of temperature, the vapor pressures of anthracene between 25 and 130°C, pyrene between 35 and 125°C, and coronene between 145 and 235°C.

28640 (DOE/PC/92544–12) **Vapor pressures and heats of vaporization of primary coal tars. Quarterly technical progress report, April 1–June 30, 1995.** Suuberg, E.M. Brown Univ., Providence, RI (United States). Div. of Engineering. [1995]. 15p. Sponsored by USDOE, Washington, DC (United States). DOE Contract FG22-92PC92544. Order Number DE96000902. Source: OSTI; NTIS; GPO Dep.

The vapor pressure correlations that exist at present for coal tars are very crude and they are not considered reliable to even an order of magnitude when applied to tars. The present project seeks to address this important gap in the near term by direct measurement of vapor pressures of coal tar fractions, by application of well-established techniques and modifications thereof. The principal objectives of the program are to: (1) obtain data on the vapor pressures and heats of vaporization of tars from a range of ranks of coal, (2) develop correlations based on a minimum set of conveniently measurable characteristics of the tars, (3) develop equipment that would allow performing such measurements in a reliable, straightforward fashion. Both the gas saturation method and the Knudsen effusion method are being used. Results are presented for anthracene, naphthacene, pentacene, and a mixture of anthracene and perylene obtained using the effusion method.

28641 (DOE/PC/93054–14) **A characterization and evaluation of coal liquefaction process streams. Status assessment.** Brandes, S.D. CONSOL, Inc., Library, PA (United States). Jul 1995. 85p. Sponsored by USDOE, Washington, DC (United States). DOE Contract AC22-94PC93054. Order Number DE96000907. Source: OSTI; NTIS; GPO Dep.

A review of the literature dealing with the modeling of fossil-fuel resid conversion to product oils and an updated assessment of the physico-chemical analytical methodology applicable to coal-liquefaction product streams is presented in this document. Analytical methodologies included here are either those which are different than those previously surveyed or are improvements on, or significantly different applications of methods previously surveyed. The literature cited spans the time period from 1991 to the present. The literature was examined from the 1960s through the present. When possible, for each model described, the methodology for deriving the model and the relative quality of the kinetic parameters derived is discussed. Proposed reaction schemes used for constructing coal-conversion models, in many cases, include the conversion of a resid intermediate to light products. These models are, therefore, also of interest, and are included here. Analytical techniques were identified that were shown to be useful for providing physico-chemical information of coal-liquefaction resids. These techniques are nuclear magnetic resonance spectroscopy, mass spectrometry (especially the technique of field ionization mass spectrometry), electron spin resonance spectroscopy coupled to thermogravimetric analysis, and a suite of petroleum inspection tests. It is recommended that these techniques be used in the present contract. 76 refs.

28642 (DOE/PC/93202–7) **Molecular accessibility in oxidized and dried coals. Quarterly report.** Kispert, L.D. Alabama Univ., University, AL (United States). Dept. of Chemistry. Jun 1995. 9p. Sponsored by USDOE, Washington, DC (United States). DOE Contract FG22-93PC93202. Order Number DE96000906. Source: OSTI; NTIS; GPO Dep.

The objective of this research project is to determine the molecular and structural changes that occur in swelled coal as a result of oxidation and moisture loss both in the presence and absence of light using the newly developed EPR spin probe method. The proposed study will make it possible to deduce the molecular accessibility distribution in swelled, oxidized APCS coal for each rank as a function of (1) size (up to 6 nm) and shape, (2) the relative acidic/basic reactive site distributions, and (3) the role of hydrogen bonding as a function of swelling solvents. The advantage of the EPR method is that it permits molecules of selected shape, size and chemical reactivity to be used as probes of molecular accessible regions of swelled coal. From such data an optimum catalyst can be designed to convert oxidized coal into a more convenient form and methods can be devised to lessen the detrimental weathering processes.

28643 (DOE/PC/93206–7) **Temperature effects on chemical structure and motion in coal. Quarterly report, April–June, 1995.** Maciel, G.E. Colorado State Univ., Fort Collins, CO (United States). Dept. of Chemistry. 30 Jun 1995. 10p. Sponsored by USDOE, Washington, DC (United States). DOE Contract FG22-93PC93206. Order Number DE96000905. Source: OSTI; NTIS; GPO Dep.

As described in previous reports, the effects of moderate temperatures (up to 230 C) is to increase molecular/macromolecular mobility in coals, as determined by ^1H CRAMPS (Combined Rotation And Multiple Pulse Spectroscopy) measurements, especially dipolar-dephasing experiments. Pyridine-saturated coals have also been studied with the same kinds of NMR experiments. The author found that thermal activation and solvent saturation promote the molecular mobility of coals in quite different ways. These results have provided some new insight into the molecular/macromolecular structure and dynamics of coals. In this report, the author compares ^1H CRAMPS results obtained on the original (untreated) Argonne Premium coal 601 with those obtained on the pyridine extraction residue of coal 601. These results are consistent with previous results and provide further information on the structure and dynamics of coals.

28644 (KRC–90C04) **Development of 3-D Simulation Program for Pulverized Coal Combustor.** Cho, Y.S. (Korea Advanced Energy Research Inst., Daeduk-Danji (Korea, Republic of). Korea Nuclear Safety Center); Park, T.J.; Lee, G.W.; Kim, G.S. Korea Electric Power Corp. (KEPCO), Taejon (Korea, Republic of). Research Center. 1993. 672p. (In Korean). Order Number DE96703577. Source: OSTI; NTIS (US Sales Only).

As the economic and social situation is becoming more complicated, the stable supply of energy fuel is one of the most important factors in a coal-fired power plant. The coal-fired power generation facilities in Korea, which is designed to use the specific coal, cannot but use domestic anthracite of low quality and twenty different kinds of imported bituminous coal. In order to operate the plant more efficiently for the various kinds of domestic and imported coals it is necessary to study the effect of the kind of fiuel used and operation conditions on the performance of coal combustors. The targets of our study are to develop a 3D simulation program for coal combustion furnaces in Seocheon Power Plant and Samcheonpo Power Plant. The coals used in Seocheon are mostly domestic anthracties of low quality and in Samcheonpo twenty different kinds of imported bituminous coals. This is the reason why the different mathematical model is developed for furnace at Seocheon and at Samcheonpo. In this study the computer program, which can predict the internal phenomena of a coal-fired furnace and the effects of various operating conditions and fuel coals on the performance of the combustors, is developed by the 3 dimensional mathematical model. The 3-D program developed here can provide the basic idea for the furnace operation. (author). 139 refs., figs.

0108 Waste Management

Refer also to citation(s) 28576, 28593, 29442, 29443, 29444, 29445

28645 (DOE/MT/92017–T1) **Simultaneous SO_2/NO_x abatement using zeolite-supported copper. Progress report, October 1, 1993–September 30, 1994.** Mitchell, M.B.; White, M.G. Clark Atlanta Univ., GA (United States). [1994]. 15p. Sponsored by USDOE, Washington, DC (United States). DOE Contract FG22-92MT92017. Order Number DE96000935. Source: OSTI; NTIS; GPO Dep.

The goals of this project have evolved from an investigation of ways of preparing Li and Hall's Cu-ZSM-5 catalyst using new methods to yield a more robust catalyst, into an investigation of modified Cu-ZSM-5 catalysts for the simultaneous reduction of NO and oxidation of SO_2. This was not a conscious effort or decision on the part of the investigators, but resulted from a natural evolution of the project. The authors have developed a zeolite synthesis and characterization capability in the group and have prepared impregnated test materials for the investigation of different catalyst precursors. They have prepared different vanadium-impregnated aluminas, for evaluation of the impregnation method, and have succeeded in reproducing the results of Li and Hall's Cu-ZSM-5 catalyst. This report reviews the progress during the first three quarters of the year, and includes progress from the last quarter. Results are discussed for the Raman spectroscopy of precursors; infrared spectroscopy of vanadium-impregnated alumina; zeolite overlayer on cordierite; reactivity of Cu-ZSM-5; and impregnation of vanadyl acetylacetonate on alumina.

28646 (DOE/MT/92017–T2) **Simultaneous SO_2/NO_x abatement using zeolite-supported copper. Progress report, October 1–December 31, 1993.** Mitchell, M.B.; White, M.G. Clark Atlanta Univ., GA (United States). [1994]. 5p. Sponsored by USDOE, Washington, DC (United States). DOE Contract FG22-92MT92017. Order Number DE96000936. Source: OSTI; NTIS; GPO Dep.

A flow reactor is being constructed at Georgia Tech for the NO decomposition reaction. The reactor is partially complete with the construction of a flow meter/controller system and a temperature controller system in place now. The stainless steel reactor tube and the furnace have been fabricated and fit to the sub-assembly containing the temperature control devices. The reactor sampling system is under fabrication. The authors plan to purchase a GC-MS to determine the composition of the exit gas. They have used Raman spectroscopy to characterize Zeolite A, a cobalt ethylenediamine complex, $Co(en)_3Cl_3$, and Zeolite A impregnated with the cobalt complex. The Raman spectra from 1,700–100 cm^{-1} are shown.

28647 (DOE/MT/92018–T1) **Investigation of combined SO_2/NO_x removal by ceria sorbents. Quarterly technical progress report, October–December, 1994.** Akyurtlu, A.; Akyurtlu, J.F. Hampton Univ., VA (United States). Dept. of Engineering. Jan 1995. 16p. Sponsored by USDOE, Washington, DC (United States). DOE Contract FG22-92MT92018. Order Number DE96000934. Source: OSTI; NTIS; GPO Dep.

Simultaneous removal of SO_2 and NO_x using a regenerable solid sorbent will constitute an important improvement over the use of separate processes for the removal of these two pollutants from stack gases and possibly eliminate several shortcomings of the individual SO_2 and NO_x removal operations. Recent studies at PETC considered cerium oxide as an alternate sorbent to CuO. The present study aims to determine the effects of ammonia on the sulfation of the sorbent and to obtain a rate expression for the regeneration of alumina-supported CeO_2 sorbents. The sulfation experiments indicated that 100% conversion of ceria could be attained. Activation energy for the sulfation reaction was found to be 19 kJ/mol. The rate of sulfation reaction is first order with respect to SO_2 and solid reactant concentrations. For regeneration with hydrogen, the activation energy and the reaction order with respect to hydrogen was found to be 114 kJ/mol and 0.56, respectively. The ceria sorbent preserved its activity and structural stability after 6 cycles. The information obtained from these studies will be used to develop models for reactor-regenerator configurations. Subsequently, the SO_2/NO_x removal facility will be integrated into the power production process using a commercial process simulation software. In this quarter of the project, the main focus was on the performance of the experimental program for the regeneration of the ceria sorbent by hydrogen and evaluation of experimental results.

28648 (DOE/PC/89652–T11) **Innovative clean coal technology (ICCT): Demonstration of selective catalytic reduction (SCR) technology for the control of nitrogen oxide (NO_x) emissions from high-sulfur coal-fired boilers. Fourth quarterly progress report.** Southern Co. Services, Inc., Birmingham, AL (United States). 1992. 50p. Sponsored by USDOE, Washington, DC (United States). DOE Contract FC22-90PC89652. Order Number DE95017340. Source: OSTI; NTIS; GPO Dep.

The objective of this project is to demonstrate and evaluate commercially available Selective Catalytic Reduction (SCR) catalysts from US, Japanese and European catalyst suppliers on a high-sulfur US coal-fired boiler. SCR is a post-combustion nitrogen oxide (NO_x) control technology that involves injecting ammonia into the flue gas generated from coal combustion in an electric utility boiler. The flue gas containing ammonia is then passed through a reactor that contains a specialized catalyst. In the presence of the catalyst, the ammonia reacts with NO_x to convert it to nitrogen and water vapor. Although SCR is widely practiced in Japan and Europe, there are numerous technical uncertainties include: (1) potential catalyst deactivation due to poisoning by trace metal species present in US coals that are not present in other fuels; (2) performance of the technology and effects on the balance-of-plant equipment in the presence of high amounts of SO_2 and SO_3; and (3) performance of a wide variety of SCR catalyst compositions,

geometries and methods of manufacture under typical high-sulfur coal-fired utility operating conditions. These uncertainties will be explored by constructing a series of small-scale SCR reactors and simultaneously exposing different SCR catalysts to flue gas derived from the combustion of high sulfur US coal.

28649 (DOE/PC/90547–T19) **Evaluation of gas reburning and low NO_x burners on a wall-fired boiler.** Energy and Environmental Research Corp., Irvine, CA (United States). Jun 1995. 50p. Sponsored by USDOE, Washington, DC (United States). DOE Contract FC22-91PC90547. Order Number DE95017754. Source: OSTI; NTIS; GPO Dep.

An evaluation of Gas Reburning (GR) and Low NO_x Burners (LNB) has been completed at Public Service Company of Colorado's Cherokee Station Unit 3. The goal of the demonstration was to reduce NO_x emissions by 70%. The reduction was to be achieved from the pre-project level prior to LNB retrofit. The GR system was supplied by Energy and Environmental Research Corporation (EER) and the LNBs were supplied by the Foster Wheeler Energy Corporation. The project was carried out in three phases in which EER designed the GR system and obtained necessary permits (Phase 1), constructed the system and completed start-up tasks (Phase 2), and evaluated its performance with both Optimization Tests and a Long-Term Demonstration (Phase 3). As directed by the Cooperative Agreement, environmental monitoring was conducted in each phase. Measurements were taken by plant personnel and an EER Field Testing Team and were divided into two types. "Compliance Monitoring" was conducted by plant personnel to satisfy requirements of regulatory agencies, while "Supplemental Monitoring" was conducted by EER personnel to develop a database of environmental impacts of the technology and to ensure environmental acceptability of the project. This document presents environmental monitoring data obtained during the Optimization Testing period, November 11, 1992 to April 23, 1993. Compliance Monitoring was conducted primarily in two areas, air emissions and aqueous discharges. The unit is required to meet an SO_2 limit of 1.2 lb/MBtu and an opacity limit of 20 percent (6 minute average). Therefore, the plant monitors flue gas SO_2 and opacity continuously and submits Excess Emissions Reports to the Colorado Air Pollution Control Division on a quarterly basis. Discharge limits for the aqueous effluent from the plant and monitoring requirements are specified by a permit issued by the Colorado Water Quality Control Division.

28650 (DOE/PC/91293–T5) **Direct catalytic decomposition of nitric oxide. Final report.** Flytzani-Stephanopoulos, M.; Sarofim, A.F.; Zhang, Yanping. Massachusetts Inst. of Tech., Cambridge, MA (United States). Dept. of Chemical Engineering. 15 Jun 1995. 67p. Sponsored by USDOE, Washington, DC (United States). DOE Contract FG22-91PC91293. Order Number DE95017760. Source: OSTI; NTIS; GPO Dep.

This project investigated a suitable catalyst system for the direct NO decomposition for post-combustion NO_x control. The studied process does not use a reductant, such as ammonia in the case of Selective Catalytic Reduction (SCR) process for catalytic reduction of NO_x to nitrogen. This is a simplified process basically involving passing the flue gas through a catalytic converter, thus avoiding problems generally associated with the commercial SCR process, namely high operating cost, ammonia slip, and potential N_2O emissions. The main results from this research project are summarized in the following: Cu-ZSM-5 and M/Cu-ZSM-5 were synthesized by incorporating metal cations into ZSM-5 zeolite supports by optimized ion exchange procedures. It was found that (1) the catalytic activity of Cu-ZSM-5 only increased with copper loading when the Cu-ZSM-5 was prepared in an aqueous copper acetate solution with pH lower than 5.74; (2) high pH of the solution led not only to ion-exchanged Cu^{2+}, but also copper deposition on the zeolite surface forming inactive CuO particles as identified by STEM/EDX and XRD; (3) the sequence of metal ion exchange first, followed by copper ion exchange to synthesize M/Cu-ZSM-5, where M represents any metal ion but copper, was important for the cocation to show promotion effects; and (4) air-calcination of M-ZSM was effective in keeping M cations in the zeolite during subsequent copper ion exchange. Positive alkaline and rare earth metal cocation effects on the Cu-ZSM-5 were identified in oxygen-containing gas mixtures in the high temperature region (450–600C). Cerium ion promoted the Cu-ZSM-5 activity in the low temperature range (< 450C) in oxygen-free gas mixture, while alkaline earth and transition metal cocations improved the NO conversion to N_2 in high temperature region.

28651 (DOE/PC/91337–T3) **An experimental study of NO_x recycle in the NOXSO flue gas cleanup process. Quarterly technical progress report, July 1–September 31, 1992.** NOXSO Corp., Library, PA (United States). [1992]. 14p. Sponsored by USDOE, Washington, DC (United States). DOE Contract AC22-91PC91337. Order Number DE95017777. Source: OSTI; NTIS; GPO Dep.

NO^x recycle represents one part of the NOXSO process. This process can remove 90% of NO_x and SO_2 simultaneously from flue gas by using a fluidized bed of sorbent. Spent sorbent is regenerated by treatment at high temperatures with a reducing gas. Adsorbed NO_X is evolved on heating the sorbent to a regeneration temperature. The concentrated stream of NO_x produced is returned to the boiler with the combustion air and reduced in the flame, which is called NO_x recycle. In the previous reporting period (from April to June), NO injection series of tests have been completed. Part of NO simultaneous injection and NO_2 injection tests were conducted. All the test results showed consistent trends. About 70% average NO_x reduction efficiency has been achieved when NO is injected into the primary air duct, which was not affected by the NO injection flow rate, the furnace load and exit O_2 concentration. When NO is injected into the secondary air duct, the NO_x reduction efficiency ranges from 46% to 60 % with dependence on the exit O_2 concentration. The NO simultaneous injection tests showed that the NO_x reduction efficiency increases with the percentage of total NO injected into the primary air duct. About 67% average NO_x reduction efficiency was demonstrated with injection of NO_2 into the secondary air duct, which is higher than that with injection of NO at the same test conditions.

28652 (DOE/PC/91337–T4) **An experimental study of NO_x recycle in the NOXSO flue gas cleanup process. Quarterly technical progress report, October 1–December 31, 1992.** NOXSO Corp., Library, PA (United States). [1992]. 8p. Sponsored by USDOE, Washington, DC (United States). DOE Contract AC22-91PC91337. Order Number DE95017778. Source: OSTI; NTIS; GPO Dep.

All the tests planed were completed. NO_2 injection tests showed higher NO_x reduction than that of NO injection at similar testing conditions. The NO_x reduction efficiency for the NO/NO_2 mixture injection is higher than that for NO injection and lower than that for NO_2 injection separately. The NO_x reduction efficiency is independent on the amount of injected gas (NO, NO_2, or NO/NO_2), but affected by the exit O_2. The optimum injection location which gives higher NO_x reduction efficiency is the primary air duct. The NO_x reduction efficiency increases with the percentage of total NO injected into the primary air duct when injecting NO into both primary air duct and secondary air duct simultaneous.

28653 (DOE/PC/91337–T5) **An experimental study of NO_x recycle in the NOXSO flue gas cleanup process. Final report.** Zhou, Q.; Haslbeck, J.L.; Neal, L.G. NOXSO Corp., Library, PA (United States). Mar 1993. 150p. Sponsored by USDOE, Washington, DC (United States). DOE Contract AC22-91PC91337. Order Number DE95017779. Source: OSTI; NTIS; GPO Dep.

NO_x recycle represents one part of the NOXSO process. This process can remove 90% of NO_x and SO_2 simultaneously from flue gas by using a fluidized bed of sorbent. Spent sorbent is regenerated by treatment at high temperatures with a reducing gas. Adsorbed NO_x is evolved on heating the sorbent to a regeneration temperature. The concentrated stream of NO_x produced is returned to the boiler with the combustion air and reduced in the flame, which is called NO_x recycle. The concept of NO_x recycle has been experimentally evaluated at the US Department of Energy's Pittsburgh Energy Technology Center (PETC). NO_x destruction has been demonstrated on a 500 lb/hr pulverized coal combustor and a 1.7 MMBtu/hr tunnel furnace combustor firing both natural gas and coal-water slurry. The NO_x recycle experimental study discussed in this report and performed on Babcock & Wilcox (B&W)'s six MMBtu/hr Small Boiler Simulator (SBS) is a pilot-scale test. The

objective is to provide further fundamental understanding and necessary information for the NOXSO full-scale demonstration at Ohio Edison's Niles Power Plant which uses the same type of cyclone burners. The experimental testing included injection of NO, NO_x and different combinations of NO/NO_2 with tile primary air (PA) and secondary air (SA) to the combustor. Results are consistent with earlier test data obtained on PETC's facility and will be used for the design of the NOXSO commercial demonstration plant at Niles.

28654 (DOE/PC/91337–T6) **An experimental study of NO_x recycle in the NOXSO flue gas cleanup process. Quarterly technical progress report, April 1–June 31, 1992.** NOXSO Corp., Library, PA (United States). [1992]. 21p. Sponsored by USDOE, Washington, DC (United States). DOE Contract AC22-91PC91337. Order Number DE95017780. Source: OSTI; NTIS; GPO Dep.

NO_x recycle is one part of the NOXSO process. In this process, 90% of the acid pollutants (NO_x and SO_2) can be removed simultaneously by adsorption on the surface of a sorbent material. The sorbent is subsequently regenerated by heating and contacting the hot sorbent with a reducing gas followed by steam. The NO_x is removed in the heating process, and the SO_2 is removed by the chemical reaction of the reducing gas and steam. The NO_x stream produced is returned to the combustion process with combustion air, which is called the NO_x recycle. The NO_x is reduced in the flame to N_2, H_2O, and CO_2. The tests of NO injection with combustion have demonstrated very promising results. The test data showed quite consistent NO_x reduction efficiencies, which is similar to the previous test results on the pulverized coal combustor at DOE-PETC. An average of about 70 % NO. destruction efficiency was achieved for the NO injection into the primary air duct independent of injected NO flow rates and exit 02 concentrations. About 58%, 50%, and 46% average destruction efficiencies were obtained for the NO injection into the secondary air duct corresponding to the exit O_2concentrations of 2%, 3%, and 4% respectively.

28655 (DOE/PC/93222–6) **No decomposition in non-reducing atmospheres. Technical progress report, December 1994–February 1995.** Klier, K.; Herman, R.G.; Jirka, I. Lehigh Univ., Bethlehem, PA (United States). May 1995. 9p. Sponsored by USDOE, Washington, DC (United States). DOE Contract FG22-93PC93222. Order Number DE95017603. Source: OSTI; NTIS; GPO Dep.

The overall goal of this research is to establish the fundamental science needed to develop catalysts that will exhibit high activity and selectivity in the decomposition of NO into N_2 and O_2. This project is centered on the preparation, characterization, and testing of transition metal exchanged catalysts, especially Co(III) zeolites. Additional Co(II) exchanged A zeolite samples have been prepared in aqueous solution at pH = 5.0-6.1 that contain different exchange levels of Co(II). Some of these have been analyzed for Na and Co contents by chemical methods and by X-ray photoelectron spectroscopy. It was shown that preparation of the samples by ion exchange between pH ≈6 and 7 tended to give stoichiometric ion exchange of Co(II) for Na^+. However, ion exchange at lower pH tended to lead to exchange with H^+ while ion exchange at higher pH tended to lead to the presence of excess Co(H), probably by precipitation of a basic Co phase. Systematic analyses of Na A zeolite, CO(II) A zeolites, and Co(II)/Ce(III) A zeolites, as well as Na X zeolite, Na Y zeolite, and Na mordenite for comparison purposes, have been carried out by X-ray photoelectron spectroscopy and Auger spectroscopy methods. Complete data analysis has not yet been carried out, but trends in some parameters have been noted, e.g. the relative intensity of the O $KL_{2,3}L_{2,3}$ line in the O ls spectral region increases as the Si Al ratio of the Na zeolites increases.

28656 (IS-M–830) **Recovery of lime from coal gasifier waste containing calcium sulfide.** Jagtap, S.B.; Wheelock, T.D. Ames Lab., IA (United States). [1995]. 7p. Sponsored by USDOE, Washington, DC (United States). DOE Contract W-7405-ENG-82. (CONF-950963–2: 8. international conference on coal science, Oviedo (Spain), 10-15 Sep 1995). Order Number DE96000208. Source: OSTI; NTIS; GPO Dep.

Calcium-based materials hold great promise as sorbents for reduced sulfur compounds at high temperature. Such materials are needed for hot gas clean up or for direct addition to coal gasifiers in several types of integrated coal gasification, combined-cycle (IGCC) power generation systems under development. However, their use has been hindered by the lack of a suitable regeneration process for converting CaS back to CaO. Recently, it was discovered in the laboratory that CaS particles can be converted rapidly and almost completely to CaO by a cyclic process which exposures the material alternately and repeatedly to oxidation and reduction at 900 to 1,100 C. During oxidation with air a small portion of CaS is converted to $CaSO_4$ which upon treatment with a reducing gas is converted to CaO. By repeating the cycle numerous times, individual particles are converted completely to CaO. Such a process can be carried out in a fluidized bed reactor which either has both oxidizing and reducing zones or is supplied with gas that is alternately oxidizing and reducing. The cyclic oxidation/reduction process for converting CaS to CaO has been demonstrated with a thermogravimetric analysis (TGA) systems, and the results are reported below. The effects of temperature and gas composition on the overall rate of conversion are indicated as well as the effect of subjecting typical sorbent materials to repeated sulfidation and regeneration.

28657 (OCDO–96000306) **Investigation of the use of fly-ash based autoclaved cellular concrete blocks in coal mines for air duct work. Final report, January 25, 1993–December 31, 1994.** Horvath, M.L. (Ohio Edison Co., Akron, OH (United States)). Ohio Coal Development Office, Columbus, OH (United States). 19 Jun 1995. 32p. Sponsored by Ohio State Government, Columbus, OH (United States). Source: OSTI; Ohio Coal Development Office, 77 S. High Street, P.O. Box 1001, Columbus, OH 43266-0001 (United States).

Coal mines are required to provide ventilation to occupied portions of underground mines. Concrete block is used in this process to construct air duct walls. However, normal concrete block is heavy and not easy to work with and eventually fails dramatically after being loaded due to mine ceiling convergence and/or floor heave. Autoclaved cellular concrete block made from (70±%) coal fly ash is lightweight and less rigid when loaded. It is lighter and easier to use than regular concrete block for underground mine applications. It has also been used in surface construction around the world for over 40 years. Ohio Edison along with eight other electric utility companies, the Electric Power Research Institute (EPRI), and North American Cellular Concrete constructed a mobile demonstration plant to produce autoclaved cellular concrete block from utility fly ash. To apply this research in Ohio, Ohio Edison also worked with the Ohio Coal Development Office and CONSOL Inc. to produce autoclaved cellular concrete block not only from coal ash but also from LIMB ash, SNRB ash, and PFBC ash from various clean coal technology projects sponsored by the Ohio Coal Development Office. The purpose of this project was to demonstrate the potential for beneficial use of fly ash and clean coal technology by-products in the production of lightweight block.

0109 Environmental Aspects

Refer also to citation(s) 28576

28658 (DOE/EIS–0210-Vol.1) **Clean coal technology project to Polk Power Station, Tampa Electric Company, Florida, Volume 1: Report.** Nuclear Regulatory Commission, Washington, DC (United States). Office of Nuclear Reactor Regulation. Jun 1994. 800p. Sponsored by USDOE, Washington, DC (United States);Environmental Protection Agency, Washington, DC (United States);Department of the Army, Washington, DC (United States). (EPA–904/9-94-002(a)). Order Number DE96000274. Source: OSTI; NTIS; INIS; GPO Dep.

Tampa Electric Company proposes to construct and operate a 1,150-MW power station in southwestern Polk County, Florida. The proposed Polk Power Station would require an EPA NPDES permit for a new source and would include a 260-MW IGCC unit as a DOE Clean Coal Technology demonstration project. This EIS document assesses the proposed project and alternatives with respect to environmental impacts. Mitigative measures are also evaluated for the preferred alternative. Included in this Volume I are the following: alternatives including Tampa Electric Companies proposed project (preferred alternative with DOE financial assistance); affected environment; environmental consequences of the alternatives.

28659 (DOE/EIS–0210-Vol.2) **Clean coal technology project to Polk Power Station, Tampa Electric Company, Florida. Final report, Volume II: Report and appendices.** Nuclear Regulatory Commission, Washington, DC (United States). Office of Nuclear Reactor Regulation. Jun 1994. 750p. Sponsored by USDOE, Washington, DC (United States);Environmental Protection Agency, Washington, DC (United States);Department of the Army, Washington, DC (United States). (EPA–904/9-94-002(b)). Order Number DE96000275. Source: OSTI; NTIS; INIS; GPO Dep.

Tampa Electric Company proposes to construct and operate a 1,150-MW power station in southwestern Polk County, Florida. The proposed Polk Power Station would require an EPA NPDES permit for a new source and would include a 260-MW IGCC unit as a DOE Clean Coal Technology demonstration project. This EIS document assesses the proposed project and alternatives with respect to environmental impacts. Mitigative measures are also evaluated for the preferred alternative. This Volume II includes the following appendices: summary of potential adverse impacts of the proposed project and identification and evaluation of impact avoidance, minimization, and mitigative measures; summary of EIS findings; public participation and coordination efforts.

28660 (LBL–37200, pp. 239-244) **Modeling acid mine drainage in waste rock dumps.** Lefebvre, R. (INRS, Quebec (Canada)). Lawrence Berkeley Lab., CA (United States). Mar 1995. DOE Contract AC03-76SF00098. (CONF-9503110–: TOUGH 95: transport of unsaturated ground water and heat workshop, Berkeley, CA (United States), 20-22 Mar 1995). In *Proceedings of the TOUGH Workshop '95 Lawrence Berkeley Laboratory, Berkeley, California, March 20–22, 1995*. 380p. Order Number DE95014788. Source: OSTI; NTIS; GPO Dep.

Acid mine drainage (AMD) results from the oxidation of sulfides present in mine wastes. The acidity generated by these reactions creates conditions under which metals can be leached and represent a threat for surface and ground waters. Even though leachate collection and neutralization are used to treat the problem, the industry is looking for methods to predict and prevent the generation of AMD at new sites and control methods for sites already producing AMD. Waste rock dumps are generally very large accumulations of barren rocks extracted from open pits to access ore bodies. These rocks contain sulfides, most commonly pyrite, and often generate AMD at rates much higher than in mine tailings which are fine grained by-products of milling operations. Numerous coupled physical processes are involved in AMD production in waste rocks. Sulfide oxidation reactions are strongly exothermic and temperatures beyond 70°C have been measured in some dumps. That heat is transfered by conduction and fluid advection. Dumps have thick partly saturated zones through which gases flow under thermal gradients and water infiltrates. Oxygen is required by the oxidation reactions and is supplied by diffusion and advection. The reaction products are carried in solution in very concentrated leachates. Numerical modeling of AMD aims to (1) provide a better understanding of the physical processes involved in AMD, (2) allow the integration of available waste rock characterization data, (3) indicate new data or studies which are required to fill the gaps in our quantitative understanding of AMD processes, and (4) supply a tool for the prediction of AMD production, taking into account the impact of control methods. These objectives can only be met through sustained research efforts. This study is part of a wider research effort which as been on-going at La Mine Doyon since 1991.

0110 Reserves, Geology, and Exploration

Refer also to citation(s) 28737, 28738, 28739

0120 Mining

Refer also to citation(s) 30357

0130 Transport, Handling, and Storage

Refer also to citation(s) 28579, 30334

28661 (DOE/PC/90180–T14) **A theoretical and numerical study of the flow of granular materials down an inclined plane. [Quarterly progress report, January–March 1995].** Rajagopal, K.R. Pittsburgh Univ., PA (United States). Dept. of Mechanical Engineering. [1995]. 47p. Sponsored by USDOE, Washington, DC (United States). DOE Contract AC22-91PC90180. Order Number DE95017744. Source: OSTI; NTIS; GPO Dep.

The mechanics of the flowing granular materials such as coal, agricultural products, fertilizers, dry chemicals, metal ores, etc. have received a great deal of attention as it has relevance to several important technological problems. Despite wide interest and more than five decades of experimental and theoretical investigations, most aspects of the behavior of flowing granular materials are still not well understood. So Experiments have to be devised which quantify and describe the non-linear behavior of the granular materials, and theories developed which can explain the experimentally observed facts. Here we carry out a systematic numerical study of the flow of granular materials down an inclined plane using the models that stem from both the continuum theory approach and the kinetic theory approach. We also look at the existence of solutions, multiplicity and stability of solutions to the governing equations.

0140 Combustion

Refer also to citation(s) 28576, 28577, 28578, 28589, 28614, 28615, 28644, 29430, 29436, 29970, 30062, 30063, 30065, 30066, 30067, 30122, 30123, 30175, 30338

28662 (DOE/MC/24132–5002) **TIDD PFBC demonstration project. Quarterly report, January–March 1995.** American Electric Power Service Corp., Columbus, OH (United States). Apr 1995. 24p. Sponsored by USDOE, Washington, DC (United States). DOE Contract FC21-87MC24132. Order Number DE95009738. Source: OSTI; NTIS; GPO Dep.

This is the thirty-second Technical Progress Report submitted to the Department of Energy in connection with the Cooperative Agreement between the DOE and the Ohio Power Company for the Tidd PFBC Demonstration Plant. This report covers the period from January 1, 1995 to March 31, 1995. Major Activities during this period include: The unit operated for 718 hours on coal, bringing the grand total for coal fire through the end of the quarter to 11,442 hours. There were seven gas turbine starts, nine bed preheater starts, and nine operating periods on coal. During this quarter, total gross generation was 57,693 MWH, the peak unit output for one hour was 74 MWH, and the coal consumption was 27,866 tons. Twelve performance tests were conducted during this quarter, bringing the total number of tests for the plant to 95. On March 30,1995, at 8:27 am, the Tidd PFBC Demonstration Plant was manually tripped for the last time.

28663 (DOE/MC/27205–5006) **AFBC co-firing of coal and hospital waste. Quarterly progress report, November 1, 1994–January 31, 1995.** Stuart, J.M. Donlee Technologies, Inc., York, PA (United States). [1995]. 26p. Sponsored by USDOE, Washington, DC (United States). DOE Contract FC21-91MC27205. Order Number DE96000879. Source: OSTI; NTIS; GPO Dep.

The project objective is to design, construct, install, and start-up a circulating fluidized bed combustion system at the Lebanon, Pennsylvania Veteran's Affairs Medical Center. The unit will co-fire coal and hospital waste providing inexpensive and efficient destruction of both general and infectious medical waste and steam generation. Progress to date on several tasks is described. These are: Task 1.A-1.D, Design; Equipment purchase and fabrication; Installation; and Shredder system verification. Other tasks to be undertaken are: Start-up; Obtaining permits; Procuring coal, limestone and ash disposal contracts; and Conducting on-year test program. Project costs are enumerated.

28664 (DOE/MC/27229–5007) **Pulsed atmospheric fluidized bed combustion. Technical progress report, April–June 1995.** Thermochem, Inc., Columbia, MD (United States). 31 Jul 1995. 15p. Sponsored by USDOE, Washington, DC (United States). DOE Contract FC21-90MC27229. Order Number DE96000880. Source: OSTI; NTIS; GPO Dep.

Design activities for this report period included: (1) Mechanical. Stress analysis calculations were performed on the steam/water pressure piping. Pipe support design and drawings were completed

by Duke Fluor Daniel. The fluid bed distributor bubble cap design was revisited and changes made for ease of maintenance. (2) Electrical and Instrumentation. Control and instrumentation scheme proposed earlier, was based on independent single loop controllers. After careful review, it is decided to go for state of art distributed control system (DCS) which uses programmable logic controllers (PLC). In addition, coal/limestone pickup hopper fabrication was completed during this period and shipped to the site. The coal/limestone floating caps have been made at MTCI and ready for shipping. All major equipment installation was completed. The pulse combustor steam/water jacket and air plenum were installed. Construction of control room building was just completed.

28665 (DOE/MT/94013–T1) **A distributed activation energy model of heterogeneous coal ignition. Technical progress report, January 1–March 31, 1995.** Chen, J.C. North Carolina Agricultural and Technical State Univ., Greensboro, NC (United States). Dept. of Mechanical Engineering. 26 Apr 1995. 20p. Sponsored by USDOE, Washington, DC (United States). DOE Contract FG22-94MT94013. Order Number DE96000940. Source: OSTI; NTIS; GPO Dep.

Experiments designed to measure kinetic rate constants of ignition of pulverized coals showed clearly that, for single particles or dilute suspensions, particle-to-particle variations due to reactivity and/or thermophysical properties are important. There exists ample evidence that the most important factor in interpreting these data is the existence of a variation in chemical reactivity in the sample. It is surprising, therefore, to note that all previous studies presumed that a single (average) activation energy is adequate to describe the ignition process. The equations formulated using this presumption are then correlated to the experimental measurements to infer the kinetic rate constants of ignition. The major objectives are to develop a model of heterogeneous ignition which allows for a distribution of activation energies, and to implement this model to interpret previously published data. It is the authors hypothesis that variations in chemical reactivity account for the experimental trends observed. Another objective of this project is to examine the effects of variations in thermodynamic and physical properties (e.g. specific heat, particle diameter, density) on data interpretation from previous ignition experiments.

28666 (DOE/MT/94013–T2) **A distributed activation energy model of heterogeneous coal ignition. Technical progress report, April 1– June 30, 1995.** Chen, J.C. North Carolina Agricultural and Technical State Univ., Greensboro, NC (United States). Dept. of Mechanical Engineering. 5 Jul 1995. 24p. Sponsored by USDOE, Washington, DC (United States). DOE Contract FG22-94MT94013. Order Number DE96000941. Source: OSTI; NTIS; GPO Dep.

Experiments designed to measure kinetic rate constants of ignition of pulverized coals showed clearly that, for single particles or dilute suspensions, particle-to-particle variations due to reactivity and/or thermophysical properties are important. There exists ample evidence that the most important factor in interpreting these data is the existence of a variation in chemical reactivity in the sample. It is surprising, therefore, to note that all previous studies presumed that a single (average) activation energy is adequate to describe the ignition process. The equations formulated using this presumption are then correlated to the experimental measurements to infer the kinetic rate constants of ignition. The major objectives are to develop a model of heterogeneous ignition which allows for a distribution of activation energies, and to implement this model to interpret previously published data. It is the authors hypothesis that variations in chemical reactivity account for the experimental trends observed. Another objective of this project is to examine the effects of variations in thermodynamic and physical properties (e.g. specific heat, particle diameter, density) on data interpretation from previous ignition experiments. An attached paper submitted for review to "Combustion and Flame" summarizes the Distributed Activation Energy Model of Ignition, which accounts for particle-to-particle variations in reactivity within a sample by allowing for a distribution in activation energies among the particles and a single preexponential factor. The model captures the main characteristics of actual experiments, namely (1) the gradual increase in ignition frequency with increasing gas temperature and (2) the variation of the slope of the ignition frequency with O_2 concentration. Finally, it has been shown that adjustments to the model parameters can be used to fit experimental data and extract reaction rate constants.

28667 (DOE/OR/21400–T486) **Characterizing and modeling combustion of mild-gasification chars in pressurized fluidized beds.** Daw, C.S. Oak Ridge National Lab., TN (United States). [1995]. 17p. Sponsored by USDOE, Washington, DC (United States). DOE Contract AC05-84OR21400. Order Number DE96000667. Source: OSTI; NTIS; GPO Dep.

Oak Ridge National Laboratory (ORNL) is supported by the Morgantown Energy Technology Center (METC) of the Department of Energy (DOE) under FWP-FEAA310 to characterize the fuel properties of liquid and char coproducts from the mild gasification of coal, Because most of the energy content of coals subjected to mild gasification is retained in the byproduct char, efficient and cost-effective utilization of the char is essential in insuring that candidate gasification processes are commercially viable. One potential use for char of particular interest to DOE is pressurized fluidized bed combustion (PFBC). PFBC is of particular interest because it has the potential for 10 to 30 percent greater overall energy efficiency than atmospheric fluidized bed combustion (AFBC), While bench-scale tools and analytical procedures for characterizing fuels for AFBC have been recently demonstrated, no such tools have been reliably demonstrated for PFBC. This report summarizes the results of joint research collaboration between ORNL and B&W that has been directed at modifying the previously developed AFBC fuel characterization procedures to be applicable for mild-gasification chars and PFBC conditions. The specific objectives were to: (1) characterize the combustion reactivity of a selected set of candidate mild- gasification chars at PFB conditions; (2) compare the measured char characteristics with those of more conventional PFBC fuels; (3) modify an AFBC computer code previously developed by B&W and ORNL for the Electric Power Research Institute (EPRI) to predict PFBC performance; and (4) apply the modified code and measured char combustion characteristics to make performance predictions for the candidate chars relative to more conventional fuels.

28668 (DOE/PC/89651–T22) **500 MW demonstration of advanced wall-fired combustion techniques for the reduction of nitrogen oxide emissions from coal-fired boilers.** Sorge, J.N. (Southern Co. Services, Inc., Birmingham, AL (United States)); Menzies, B.; Smouse, S.M.; Stallings, J.W. Southern Co. Services, Inc., Birmingham, AL (United States). [1995]. 20p. Sponsored by USDOE, Washington, DC (United States). DOE Contract FC22-90PC89651. Order Number DE95017742. Source: OSTI; NTIS; GPO Dep.

Technology project demonstrating advanced wall-fired combustion techniques for the reduction of nitrogen oxide NOx emissions from coal-fired boilers. The primary objective of the demonstration is to determine the long-term NOx reduction performance of advanced overfire air (AOFA), low NOx burners (LNB), and advanced digital control/optimization methodologies applied in a stepwise fashion to a 500 MW boiler. The focus of this paper is to report (1) on the installation of three on-line carbon-in-ash monitors and (2) the design and results to date from the advanced digital control/optimization phase of the project.

28669 (DOE/PC/91160–T6) **Development and testing of a high efficiency advanced coal combustor: Phase 3, Industrial boiler retrofit. Quarterly technical progress report No. 13, October 1, 1994–December 31, 1994.** Patel, R.L. (ABB Combustion Engineering, Inc., Windsor, CT (United States)); Borio, R.; Scaroni, A.W.; Miller, B.G.; McGowan, J.G. ABB Combustion Engineering, Inc., Windsor, CT (United States). 7 Mar 1995. 5p. Sponsored by USDOE, Washington, DC (United States). DOE Contract AC22-91PC91160. Order Number DE95016268. Source: OSTI; NTIS; GPO Dep.

The objective of this project is to retrofit the previously developed High Efficiency Advanced Coal Combustor (HEACC) to a standard gas/oil designed industrial boiler to assess the technical and economic viability of displacing premium fuels with microfine coal. During this reporting period, activities included completing the "Task 3 Topical Report." The report is being reviewed internally by the ABB CE project team. Overall, all the program goals were met

except carbon conversion efficiency. Based on all the results obtained to date the ABB CE/Penn State team believes that conducting the 1000 hr demonstration (Task 5) is warranted. Since, Penn State has planned to conduct long term combustion tests on micronized coal and coal-water fuels for other DOE-funded Projects during the first quarter of 1995, the demonstration phase (Task 5) of the subject program is tentatively scheduled to begin in June 1995, pending DOE approval. Work continued under Task 4.0 to complete the "Commercialization Plan" with ABB CE's cognizant Business Unit. To address the lower combustion efficiency than the original project goal (95% vs 98%) during Task 3, the data were evaluated in-detail to understand which of the key parameters might be adjusted to achieve the desired burnout. To identify reasons for this lower combustion efficiency, and to evaluate which of the key parameters (i.e, coal fineness, residence time, coal reactivities etc.) are important for maximizing the combustion efficiency, ABB CE's proprietary mathematical model known as the Lower Furnace Program-Slice Kinetic Model (LFP-SKM) was used for simulating the combustion process in the Penn State boiler (at full load firing rate). Fuel kinetic information for this study was selected on a surrogate basis from ABB CE's extensive in-house data base.

28670 (DOE/PC/91160–T7) **Development and testing of a high efficiency advanced coal combustor: Phase III, Industrial boiler retrofit. Quarterly technical progress report No. 14, January 1, 1995–March 31, 1995.** Patel, R.L. (ABB Combustion Engineering Systems, Windsor, CT (United States). U.S. Power Plant Labs.); Borio, R.; Scaroni, A.W.; Miller, B.G.; McGowan, J.G. ABB Combustion Engineering Systems, Windsor, CT (United States). U.S. Power Plant Labs. 28 Apr 1995. 9p. Sponsored by USDOE, Washington, DC (United States). DOE Contract AC22-91PC91160. Order Number DE95017749. Source: OSTI; NTIS; GPO Dep.

The objective of this project is to retrofit the previously developed High Efficiency Advanced Coal Combustor (HEACC) to a standard gas/oil designed industrial boiler to assess the technical and economic viability of displacing premium fuels with microfine coal. This report documents the technical aspects of this project during the fourteenth quarter (January '95 through March '95) of the program. The ABB project team met with cognizant DOE-PETC and Penn State personnel on February 15, 1995 at Penn State to discuss our ideas for a new burner (RSFC-based) to replace the HEACC burner prior to the long term (~1000 hrs) demonstration phase of this project. The main reasons for the proposed new burner were to improve combustion efficiencies and NO_x reduction. Recent, experience at MIT with 5 million Btu/hr coal firing experiments on RSFC burner have shown remarkable performance. Results indicate that RSFC-based burner has the potential to produce lower NO_x and higher carbon conversion efficiencies than the HEACC burner. M.I.T. developed the RSFC burner and obtained a patent for the concept. A decision was made to go with the new, RSFC-based burner during 1000 hr demonstration. ABB-CE will fund the costs (~$50K) for design/fabrication of the proposed new burner. Penn State plans to improve coal handling by installation of a gravimetric feeder and redesign/installation of a mass flow bottom on the surge bin.

28671 (DOE/PC/91306–T2) **Sorption and chemical transformation of PAHs on coal fly ash. Final technical report.** Mamantov, G.; Wehry, E.L. Tennessee Univ., Knoxville, TN (United States). Dept. of Chemistry. Feb 1995. 26p. Sponsored by USDOE, Washington, DC (United States). DOE Contract FG22-91PC91306. Order Number DE96000963. Source: OSTI; NTIS; GPO Dep.

The objectives of this work were to characterize the interactions of coal fly ash with polycyclic aromatic hydrocarbons (PAH's) and their derivatives, and to attempt to understand the influence of surface properties of coal ash in the chemical transformations of PAH's.

28672 (DOE/PC/92190–T8) **Fundamental study of ash formation and deposition: Effect of reducing stoichiometry. Quarterly Report No. 8, January 1, 1995–March 31, 1995.** Bool, L.E. III (and others); Helble, J.J.; Sarofim, A.F. USDOE Pittsburgh Energy Technology Center, PA (United States). May 1995. 50p. Sponsored by USDOE, Washington, DC (United States). DOE Contract AC22-93PC92190. (PSI–1178/05/95). Order Number DE95017753. Source: OSTI; NTIS; GPO Dep.

The objectives of this research program include: the identification of the partitioning of inorganic coal constituents among vapor, submicron fume, and fly ash products generated during pulverized coal combustion; identification of fundamental processes by which the transformation of minerals and organically associated species occurs; the incorporation of the effects of combustion stoichiometry into an engineering model for ash formation.

28673 (DOE/PC/94119–T5) **Development of a phenomenological model for coal slurry atomization. Quarterly technical progress report, April–June, 1995.** Dooher, J. Adelphi Univ., Garden City, NY (United States). Dept. of Physics. [1995]. 6p. Sponsored by USDOE, Washington, DC (United States). DOE Contract FG22-94PC94119. Order Number DE96000938. Source: OSTI; NTIS; GPO Dep.

A theoretical derivation is presented with a presentation of the various pressure drops occurring in the extensional viscometer. In particular, by using energy considerations the meaning of each pressure drop is clearly delineated. This allows for unambiguous data analysis. In the coming quarter, pressure transducers will be added to the viscometer and a series of tests performed on fluids with extensional flow properties.

28674 (ETDE/CH-mf–95787322, pp. 66-68) **Reduction of NO and SO_2 in two-stage fluidized shallow bed coal combustor (100 kW_{th}).** Tsukada, A. (Paul Scherrer Inst. (PSI), Villigen (Switzerland)); Schaeren, R. Paul Scherrer Inst. (PSI), Villigen (Switzerland). 1995. In *Paul Scherrer Institut annual report 1994. Annex V: PSI general energy technology newsletter 1994.* 123p. Source: OSTI; NTIS.

The reduction of fuel-nitrogen oxide NO by means of staged air injection and the retention of sulfur dioxide SO_2 in the case of the 100 kW laboratory coal combustor with one-way sorbent usage are presented here (without cyclone, but with two fluidized beds in series). The pollutant emissions (besides fuel-NO) conform to the Swiss Federal Clean Air Act of February 92 for extra light fuel oil. A high volatile bituminous coal containing 1.06 weight % of nitrogen and 0.55 weight % of sulfur has been used. (author) 4 figs., 7 refs.

28675 (KRC–91G-J03) **Investigation of Flame Structures Temperature and Heat Flux Measurements.** Kim, T.S. (Korea Electric Power Corp. (KEPCO), Taejon (Korea, Republic of). Research Center); Kim, J.S.; Song, K.C.; Lee, S.K.; Park, Y.J.; Im, C.S.; Park, W.C.; Choi, S.M.; Song, T.H.; Shin, Y.S.; Ha, K.S.; Chung, K.B.; Lee, M.J.; Kim, S.Y.; Shin, D.H.; YKorea Electric Power Corp. (KEPCO), Taejon (Korea, Republic of). Research Center. 1993. 304p. (In Korean). Order Number DE96703592. Source: OSTI; NTIS (US Sales Only).

For the optimal management of combustion conditions, it is essential to understand the flame structures. Since our company owns and operates many different types of boilers and burners, and uses diverse fuels technologies on combustion diagnostics and combustion control are critically in demand. The research on the diagnostics and technologies will enable us to enhance the related combustion techniques, and to offer basic methods of combustion research. It will also establish a standard for the combustion of future power plants. (author). 14 refs., fig.

28676 (ORNL–6874, pp. 7-16) **Forced chemical vapor infiltration of tubular geometries: Modeling, design, and scale-up.** Stinton, D.P. (and others); Besmann, T.M.; Matlin, W.M. Oak Ridge National Lab., TN (United States). Jun 1995. In *Fossil Energy Program annual progress report for April 1994 through March 1995.* 203p. Order Number DE95015441. Source: OSTI; NTIS; GPO Dep.

In advanced indirectly fired coal combustion systems and externally fired combined cycle concepts, ceramic heat exchangers are required to transfer heat from the hot combustion gases to the clean air that drives the gas turbines. For high efficiencies, the temperature of the turbine inlet needs to exceed 1100°C and preferably be about 1260°C. The heat exchangers will operate under pressure and experience thermal and mechanical stresses during heating and cooling, and some transients will be severe under upset conditions. Silicon carbide-matrix composites are promising for such applications because of their high strength at

elevated temperature, light weight, thermal and mechanical resistance, damage tolerance, and oxidation and corrosion resistance. Fiber-reinforced composite tubes of several fiber architectures were fabricated by forced chemical vapor infiltration (FCVI) and characterized. Unfortunately, long times (~150 hours) were required to thoroughly density the tubes. An objective of the current investigation was to optimize the forced CVI process so that composite tubes could be fabricated in much shorter times. To aid in such optimization, a computer code which models the CVI process was used to identify critical process parameters. Finally, successful demonstration of the utility of composite tubes for these applications will require the testing of near-full scale components. As a result a new infiltration system was designed and constructed to prepare 10-cm diameter tubes, and is described in this report.

0150 Economic, Industrial, and Business Aspects

Refer also to citation(s) 29819

02 PETROLEUM

Refer also to citation(s) 29874

0202 Reserves, Geology, and Exploration

Refer also to citation(s) 28693, 28694, 28695, 28699

28677 (DOE/BC/14831–14-Rev.1) **Assist in the recovery of bypassed oil for reservoirs in the Gulf of Mexico. Annual report, February 1994–February 1995.** Schenewerk, P. Louisiana State Univ., Baton Rouge, LA (United States). Dept. of Petroleum Engineering. Sep 1995. 239p. Sponsored by USDOE, Washington, DC (United States). DOE Contract AC22-92BC14831. Order Number DE95000185. Source: OSTI; NTIS; GPO Dep.

A report on the simulation work performed on the U-8 reservoir was completed. Upon completing the history match of the reservoir and the running of several predictive runs, evidence indicates the following: layers "A" and "B" of the U-8 sand are in communication; the given reservoir relative permeability data was not appropriate for the U-8 sand reservoir and the relative permeabilities were modified to enable a history match to be obtained; the vertical permeability values were found to be within the accepted range for the Gulf of Mexico ($0.1Kx < Kz < 0.5Kx$, with $Kx = Ky$) at 0.4 Kx; based on industry's desired design (water injection of 5100 BBL/D), the best possible production scenario is in the northeastern portion of the reservoir: if the water injection rate is doubled 10,200 MSTB/D, the additional oil recovery may be increased by 33% (1,214 MSTB) in the vertical well scenario and by 37% (1,320 MSTB) in the horizontal well scenario; by converting the production wells to water injection wells and drilling a horizontal production well in the north-central portion of the reservoir, the production obtained is approximately 90% of the production obtained from the northeastern portion of the reservoir at the same field injection rate. Also, modifications to handle steeply dipping reservoirs have been successfully implemented in the MASTER simulator and critical process parameter laboratory experiments and computer simulations of the experiments have been completed. Development of predictive models for undeveloped oil and immiscible/miscible processes began. The methodology for determination of undeveloped potential has been completed. The design of the miscible and updip displacement models as well as the design of the economic and timing models is underway. The coding and calibration of the models began. Data validation, map measurements, model development and supporting cost data collection was in progress.

28678 (DOE/BC/14896–8) **Geological and petrophysical characterization of the Ferron Sandstone for 3-D simulation of a fluvial-deltaic reservoir. Technical progress report, April 1–June 30, 1995.** Allison, M.L. Utah Geological and Mineral Survey, Salt Lake City, UT (United States). 28 Jul 1995. 12p. Sponsored by USDOE, Washington, DC (United States). DOE Contract AC22-93BC14896. Order Number DE95017585. Source: OSTI; NTIS; GPO Dep.

The objective of this project is to develop a comprehensive, interdisciplinary, and quantitative characterization of a fluvial-deltaic reservoir which will allow realistic inter-well and reservoir-scale modeling to be constructed for improved oil-field development in similar reservoirs world-wide. The geological and petrophysical properties of the Cretaceous Ferron Sandstone in east-central Utah will be quantitatively determined. Both new and existing data will be integrated into a three-dimensional representation of spatial variations in porosity, storativity, and tensorial rock permeability at a scale appropriate for inter-well to regional-scale reservoir simulation. Results could improve reservoir management through proper infill and extension drilling strategies, reduction of economic risks, increased recovery from existing oil fields, and more reliable reserve calculations. Technical progress this quarter is divided into regional stratigraphy, case studies, stochastic modeling and fluid-flow simulation, and technology transfer activities. The regional stratigraphy of the Ferron Sandstone outcrop belt from Last Chance Creek to Ferron Creek is being described and interpreted. Photomosaics and a database of existing surface and subsurface data are being used to determine the extent and depositional environment of each parasequence, and the nature of the contacts with adjacent rocks or flow units. For the second field season, detailed geological and petrophysical characterization of the primary reservoir lithofacies typically found in a fluvial-dominated deltaic reservoir, is continuing at selected case-study areas.

28679 (DOE/BC/14934–1) **Increasing waterflood reserves in the Wilmington oil field through improved reservoir characterization and reservoir management. Quarterly technical progress report, March 21, 1995–June 30, 1995.** Sullivan, D. (Long Beach City Dept. of Oil Properties, CA (United States)); Clarke, D.; Walker, S.; Phillips, C.; Nguyen, J.; Moos, D.; Tagbor, K. Long Beach City Dept. of Oil Properties, CA (United States). 26 Jul 1995. 18p. Sponsored by USDOE, Washington, DC (United States). DOE Contract FC22-95BC14934. Order Number DE95017085. Source: OSTI; NTIS; GPO Dep.

The main objective of this project is the transfer of technologies, methodologies, and findings developed and applied in this project to other operators of Slope and Basin Clastic Reservoirs. This project will study methods to identify sands with high remaining oil saturation and to recomplete existing wells using advanced completion technology. The identification of the sands with high remaining oil saturation will be accomplished by developing a deterministic 3-D geologic model and by using a state of the art reservoir management computer software. The wells identified by the geologic and reservoir engineering work as having the best potential will be logged with a pulsed acoustic cased-hole logging tool. The application of the logging tools will be optimized in the lab by developing a rock-log model. The wells that are shown to have the best oil production potential will be recompleted. The recompletions will be optimized by evaluating short radius and ultra-short radius lateral recompletions. Technical progress is reported for the following tasks: Reservoir characterization; reservoir engineering; 3-D geologic modeling; pulsed acoustic logging; and technology transfer.

28680 (DOE/BC/14953–11) **Increased oil production and reserves from improved completion techniques in the Bluebell Field, Uinta Basin, Utah. Seventh quarterly technical progress report, April 1, 1995–June 30, 1995.** Morgan, C.D. Utah Dept. of Natural Resources, Salt Lake City, UT (United States). [1995]. 12p. Sponsored by USDOE, Washington, DC (United States). DOE Contract FC22-93BC14953. Order Number DE95016922. Source: OSTI; NTIS; GPO Dep.

The objective of this project is to increase oil production and reserves in the Uinta Basin by demonstrating improved completion techniques. Low productivity of Uinta Basin wells is caused by gross production intervals of several thousand feet that contain perforated thief zones, water-bearing zones, and unperforated oil-bearing intervals. Geologic and engineering characterization and computer simulation of the Green River and Wasatch formations in the Bluebell field will determine reservoir heterogeneities related to fractures and depositional trends. This will be followed by drilling and recompletion of several wells to demonstrate improved completion techniques based on the reservoir characterization. Transfer of the project results will be an ongoing component of the project.

Technical progress for this quarter are discussed for subsurface and engineering studies.

28681 (DOE/BC/14970–4) **GYPSY field project in reservoir characterization. Quarterly progress report, April 1, 1995–June 30, 1995.** O'Meara, D.J. Jr. Oklahoma Univ., Norman, OK (United States). 1995. 30p. Sponsored by USDOE, Washington, DC (United States). DOE Contract FG22-94BC14970. Order Number DE95017773. Source: OSTI; NTIS; GPO Dep.

We study the determination of possibly discontinuous reservoir parameter functions defined on two dimensional regions from sparse pointwise measurements supplemented with measurements of a nonlinear function of the parameter. The specific application we have in mind is that of determining a permeability function from core measurements and pressure data, cf. Our approach involves two steps. The first is to detect the discontinuous behavior, and the second is to isolate and refine the region containing it. For the first step we use a regularized output least squares procedure in which the reservoir mapping is approximated by linear combinations of bicubic B-splines. The regularization used is the H^1 seminorm that is related to the potential energy functional of an elastic membrane. This regularization gives sufficient compactness to obtain the existence of a solution to the associated minimization problem while implying minimal additional smoothing. The result of the procedure is to obtain a discontinuous function. We then essentially subtract this function from the model coefficient thereby, at least intuitively, reducing the discontinuous behavior. In Section 2 we discuss the estimation of parameters by a regularized output least squares method in which there are data available in the form of measurements of permeability and pressure at locations within a two dimensional reservoir. Of interest here is the detection of the presence of features in the permeability function. In Section 4 we describe a procedure to isolate the anomalies that have been detected. Essentially we seek a piecewise constant function possessing a rectangular subregion containing the feature of interest. Having found such a function, we again consider the regularized output least squares method to detect further anomalies in the permeability function repeating the procedure. Finally, Section 5 is devoted to the reporting the outcome of several numerical experiments.

28682 (DOE/BC/14984–5) **Improved recovery demonstration for Williston basin carbonates. Annual report, June 10, 1994–June 9, 1995.** Sippel, M.; Zinke, S.; Magruder, G.; Eby, D. Syndetix, Inc., Las Cruces, NM (United States). Sep 1995. 86p. Sponsored by USDOE, Washington, DC (United States). DOE Contract FC22-94BC14984. Order Number DE95000186. Source: OSTI; NTIS; GPO Dep.

The purpose of this project is to demonstrate targeted infill and extension drilling opportunities, better determinations of oil-in-place, methods for improved completion efficiency and the suitability of waterflooding in Red River and Ratcliffe shallow-shelf carbonate reservoirs in the Williston Basin, Montana, North Dakota and South Dakota. Improved reservoir characterization utilizing three-dimensional and multi-component seismic are being investigated for identification of structural and stratigraphic reservoir compartments. These seismic characterization tools are integrated with geological and engineering studies. Improved completion efficiency is being tested with extended-reach jetting lance and other ultra-short-radius lateral technologies. Improved completion efficiency, additional wells at closer spacing and better estimates of oil in place will result in additional oil recovery by primary and enhanced recovery processes.

28683 (DOE/BC/14989–6) **Application of integrated reservoir management and reservoir characterization to optimize infill drilling. Quarterly progress report, June 13, 1995–September 12, 1995.** Pande, P.K. Fina Oil and Chemical Co., Midland, TX (United States). 12 Sep 1995. 10p. Sponsored by USDOE, Washington, DC (United States). DOE Contract FC22-94BC14989. Order Number DE96001044. Source: OSTI; NTIS; GPO Dep.

At this stage of the reservoir characterization research, the main emphasis is on the geostatistics and reservoir simulation. Progress is reported on geological analysis, reservoir simulation, and reservoir management.

28684 (LBL–37200, pp. 157-162) **Analysis of over-pressure mechanisms in the Uinta Basin, Utah.** McPherson, B. (Geological Survey, Menlo Park, CA (United States)); Bredehoeft, J. Lawrence Berkeley Lab., CA (United States). Mar 1995. DOE Contract AC03-76SF00098. (CONF-9503110–: TOUGH 95: transport of unsaturated ground water and heat workshop, Berkeley, CA (United States), 20-22 Mar 1995). In *Proceedings of the TOUGH Workshop '95 Lawrence Berkeley Laboratory, Berkeley, California, March 20–22, 1995.* 380p. Order Number DE95014788. Source: OSTI; NTIS; GPO Dep.

Extremely high pore fluid pressures exist in the area of the Altamount/Bluebell oil field in the Uinta basin, Utah. We discuss two possible mechanisms for the cause of these over-pressures in this paper: (1) compaction disequilibrium, and (2) conversion of kerogen to liquid hydrocarbon (oil). Compaction disequilibrium occurs during periods of rapid sedimentation. If the permeability of deeply buried strata is low, then connate water within the rock matrix does not escape rapidly enough as compaction occurs; as sedimentary deposition continues, high pore fluid pressures develop. Conversion of solid kerogen to a liquid generates both a liquid and additional pore space for the liquid to occupy. If the volume of the liquid generated is just sufficient to fill the pore space generated, then there will be no accompanying effect on the pore pressure. If the liquid is less dense than the solid it replaces, then there is more liquid than pore space created; pore pressure will increase, causing flow away from the area of the reaction. Pore pressure is a sensitive measure of the balance between hydrocarbon generation and expulsion from the source into adjacent strata. If high pore pressures exist only where source rocks are thought to be generating oil, then kerogen conversion is a likely over-pressure mechanism. However, if over-pressures are found in low-permeability strata regardless of source rock proximity, then sedimentary compaction is probably a more dominant mechanism.

28685 (NEI-NO–576) **Traveltime inversion of seismic data with special application to VSP.** Elde, R.M. Bergen Univ. (Norway). 1994. 193p. Order Number DE96703731. Source: OSTI; NTIS.

The aim of this doctoral thesis is to study the traveltime inversion technique and to apply traveltime inversion to seismic data from the North Sea. A traveltime inversion algorithm has been developed and used on synthetic and real data. Both surface seismic data and seismic data collected in wells are considered. The traveltime inversion is based on a ray-theoretic form of tomography where the integrals are traveltimes along the raypaths. An iterative least-squares inversion technique is used to determine a velocity model in the illuminated area. Only two-dimensional layered models are considered. Each layer is homogeneous, elliptically anisotropic and separated by curved interfaces. Each interface is characterized by a number of nodes connected by cubic splines. These nodes, and the principal velocities in the elliptical velocity model, are parameters in the inversion. The traveltime inversion is performed layer by layer. The thesis also includes four papers, three of which demonstrate traveltime inversion of different types of VSP data and surface seismic data. The fourth paper deals with VSP data from a more complex structural area where two-dimensional traveltime inversion is very difficult. 84 refs., 99 figs., 2 tabs.

28686 (NEI-NO–577) **Geometric and kinematic analysis of tertiary fold and thrust structures in Spitsbergen, Svalbard: Comparison with the Rocky Mountain foreland.** Braathen, A. Tromsoe Univ. (Norway). Dec 1994. 173p. Order Number DE96703730. Source: OSTI; NTIS.

This thesis describes the structural geometry, the style and evolution of Tertiary deformation in west-central Spitsbergen and provides a base for discussion of possible tectonic implications relevant to the opening of the northern Norwegian-Greenland Sea. The thesis aims to use field observations together with seismic sections to place constraints on: (1) Geometrical aspects of Tertiary deformation structures in key areas along the western and central margin of the fould-thrust belt, i.e., in western Nordenskjoeld Land and Oscar II Land, (2) Kinematic and dynamic aspects of uplift of the fould-thrust complex in western Nordenskjoeld Land, (3) Subsurface geometries in the west-central Isfjorden area, based on

interpretation of a seismic data set, (4) Factors (subsurface/pre-existing) controlling geometry, structural zonation, and location of major Tertiary thrusts in western Nordenskjoeld Land and Oscar II Land, (5) A basement-uplift in south-central Wyoming of the Rocky Mountain foreland, USA. These data form the basis for a structural analysis of west-central Spitsbergen, and for a comparison with the Rocky Mountain foreland, aiming to discuss and evaluate existing kinematic models for the Spitsbergen region. The details are given in five included papers. 388 refs., 61 figs.

28687 (NEI-NO–578) **Late Pleistocene evolution of the submarine fans off the western Barents Sea margin.** Laberg, J.S. Tromsoe Univ. (Norway). Nov 1994. 140p. Order Number DE96703729. Source: OSTI; NTIS.

In five included papers, this doctoral thesis aims to: (1) Outline the Late Pleistocene growth pattern of the Bear Island Trough Mouth Fan (TMF) and to identify the primary sediment sources, (2) Elucidate the sedimentary processes on the Bear Island TMF and to discuss their relation to the glacial history of the southwestern Barents Sea continental margin, (3) Elucidate the age and cause of a large-scale slide on the southern fan flank in detail, (4): Elucidate the morphology and seismic facies distribution of the Storfjorden TMF and to make a comparative study to the Bear Island TMF and river-fed fans, and (5): Reveal the large-scale pattern of slope processes on a glacier-influenced continental margin as exemplified by the Norwegian-Greenland Sea margins. The study is based on high-resolution seismic sparker data, side-scan sonar and gravity cores. The thesis concludes that the evolution of the Bear Island TMF and the Storfjorden TMF differ in many aspects from the evolution of most of the low-latitude, river-fed submarine fans studied so far. 259 refs., 61 figs., 9 tabs.

0203 Drilling and Production

Refer also to citation(s) 28677, 28679, 28680, 28681, 28682, 30358, 30722

28688 (DOE/BC/14832–3) **Continued support of "the Natural Resources Information System (NRIS) for the State of Oklahoma": Inclusion of a Native American focused effort. Quarterly technical progress report, April 1, 1995–June 30, 1995.** Mankin, C.J. (Oklahoma Geological Survey, Norman, OK (United States)); Banken, M.K. Oklahoma Univ., Norman, OK (United States). 19 Sep 1994. 4p. Sponsored by USDOE, Washington, DC (United States). DOE Contract FG22-94BC14832. Order Number DE95017774. Source: OSTI; NTIS; GPO Dep.

The objective of this research program is to continue developing, editing, maintaining, utilizing and making publicly available the Oil and Gas Well History file portion of the Natural Resources Information System (NRIS) for the State of Oklahoma. The Oklahoma Geological Survey, working with Geological Information Systems at the University of Oklahoma Sarkeys Energy Center, has undertaken to construct this information system in response to the need for a computerized, centrally located library containing accurate, detailed information on the state's natural resources. Particular emphasis during this phase of NRIS Well History development is being placed on oil and gas data for Osage County, which is under the authority of the Osage Tribal Council. Well History file processing, special projects are undertaken to add supplemental data to the file from well logs, scout tickets, and core and sample documentation.

28689 (DOE/BC/14880–14) **Improved techniques for fluid diversion in oil recovery. Quarterly technical progress report, July 1, 1995–September 30, 1995.** Seright, R.S. New Mexico Highlands Univ., Las Vegas, NM (United States). Dept. of Chemistry. [1995]. 4p. Sponsored by USDOE, Washington, DC (United States). DOE Contract AC22-92BC14880. Order Number DE96001045. Source: OSTI; NTIS; GPO Dep.

This three-year project has two general objectives. The first objective is to compare the effectiveness of gels in fluid diversion with those of other types of processes. Several different types of fluid-diversion processes are being compared, including those using gels, foams, emulsions, and particulates. The ultimate goals of these comparisons are to (1) establish which of these processes is most effective in a given application and (2) determine whether aspects of one process can be combined with those of other processes to improve performance. Analyses are being performed to assess where the various diverting agents will be most effective (e.g., in fractured vs. unfractured wells, deep vs. near-wellbore applications, reservoirs with vs. without crossflow, or injection wells vs. production wells). Experiments are being performed to verify which materials are the most effective in entering and blocking high-permeability zones. Another objective of the project is to identify the mechanisms by which materials (particularly gels) selectively reduce permeability to water more than to oil. In addition to establishing why this occurs, our research attempts to identify materials and conditions that maximize this disproportionate permeability reduction.

28690 (DOE/BC/14884–14) **Surfactant loss control in chemical flooding: Spectroscopic and calorimetric study of adsorption and precipitation on reservoir minerals. Quarterly progress report, April 1, 1995–June 30, 1995.** Somasundaran, P. Columbia Univ., New York, NY (United States). 31 Aug 1995. 11p. Sponsored by USDOE, Washington, DC (United States). DOE Contract AC22-92BC14884. Order Number DE96000308. Source: OSTI; NTIS; GPO Dep.

Previously, adsorption and desorption behaviors of tetradecyl trimethyl ammonium chloride (TTAC) and pentadecylethoxylated nonyl phenol (NP-15) mixtures have been reported. It was observed that there was either synergistic or competitive adsorption between these two surfactants depending on the mixture ratios and the concentrations studied and that their adsorption/desorption behaviors were also rather complex. To better elucidate the mechanisms involved in these adsorption and desorption processes it is important to the understand the exact nature of the physico-chemical interactions between various components in mixtures and, how this in turn, controls the performance of the surfactant systems. Recently we have adapted the ultrafiltration technique to determine monomer concentrations in surfactant mixtures and to study the aggregation phenomenon between TTAC and NP-15. During the current report period, monomer concentrations of TTAC and NP-15 were measured for different mixing ratios at a constant ionic strength of 0.03 M NaCl and after adsorption for 4:1 TTAC:NP-15 mixture system. Possible behaviors of mixed micellization processes in solution are proposed and the relationship between monomer concentration and adsorption density is discussed.

28691 (DOE/BC/14886–13) **Investigation of oil recovery improvement by coupling an interfacial tension agent and a mobility control agent in light oil reservoirs. Technical progress report, July 1995–September 1995.** Pitts, M.J. Surtek, Inc., Golden, CO (United States). [1995]. 4p. Sponsored by USDOE, Washington, DC (United States). DOE Contract AC22-92BC14886. Order Number DE96001047. Source: OSTI; NTIS; GPO Dep.

This study will investigate two major areas concerning co-injection and interfacial tension reduction agents and a mobility control agent into petroleum reservoirs. The first will consist of defining the mechanisms of interaction of an alkaline agent, a surfactant, and a polymer on a fluid-fluid and a fluid-rock basis. The second is the improvement of the economics of the combined technology. This report examines altering the concentration of alkali and polymer on the oil recovery economics of alkaline-surfactant-polymer solution.

28692 (DOE/BC/14899–30) **Research on oil recovery mechanisms in heavy oil reservoirs. [Quarterly] report, April–June 30, 1995.** Brigham, W.E. Stanford Univ., CA (United States). Petroleum Research Inst. [1995]. 6p. Sponsored by USDOE, Washington, DC (United States). DOE Contract FG22-93BC14899. Order Number DE95017092. Source: OSTI; NTIS; GPO Dep.

The goal of the Stanford University Petroleum Research Institute is to conduct research directed toward increasing the recovery of heavy oils. Presently, SUPRI is working in five main directions: (1) Flow properties studies – To assess the influence of different reservoir conditions (temperature and pressure) on the absolute and relative permeability to oil and water and on capillary pressure. (2) In-situ combustion – To evaluate the effect of different reservoir parameters on the in-situ combustion process. Ibis project includes the study of the kinetics of the reactions. (3) Steam with additives -

To develop and understand the mechanisms of the process using commercially available surfactants for reduction of gravity override and channeling of steam. (4) Formation evaluation – To develop and improve techniques of formation evaluation such as tracer tests and pressure transient tests. (5) Field support services – To provide technical support for design and monitoring of DOE sponsored or industry initiated field projects. Accomplishments for this quarter are briefly described for each study.

28693 (DOE/BC/14954–12) **Advanced secondary recovery demonstration for the Sooner Unit. Progress report, July 1–September 30, 1995.** Sippel, M.A.; Cammon, T.J. Diversified Operating Corp., Denver, CO (United States). 30 Sep 1995. 2p. Sponsored by USDOE, Washington, DC (United States). DOE Contract FC22-93BC14954. Order Number DE96001129. Source: OSTI; NTIS; GPO Dep.

The objective of this project is to increase production from the Cretaceous "D" Sand in the Denver-Julesburg (D-J) Basin through geologically targeted infill drilling and improved reservoir management of waterflood operations. This project involves multidisciplinary reservoir characterization using high-density 3-D seismic, detailed stratigraphy and reservoir simulation studies. Infill drilling, water-injection conversion and recompleting some wells to add short-radius laterals will be based on the results of the reservoir characterization studies. Production response will be evaluated using reservoir simulation and production tests. Technology transfer will utilize workshops, presentations and technical papers which will emphasize the economic advantages of implementing the demonstrated technologies. The success of this project and effective technology transfer should prompt-re-appraisal of older waterflood projects and implementation of new projects in oil provinces such as the D-J Basin. Three wells have been drilled by the project based on 3-D seismic and integrated reservoir characterization study. Oil production has increased in September to 54.0 m^3/D (340 bopd) after the completion of the SU 21-16-9. Combination-attribute maps from 3-D seismic data closely predicted the net-pay thickness of the new well. Inter-well tracer tests with sodium bromide indicate a high-permeability channel between two wells. An oral presentation was made at the Rocky Mountain AAPG meeting in Reno, NV.

28694 (DOE/BC/14956–10) **Identification and evaluation of fluvial-dominated deltaic (Class 1 oil) reservoirs in Oklahoma. Quarterly technical progress report, October 1, 1994–December 31, 1994.** Mankin, C.J. (Oklahoma Geological Survey, Norman, OK (United States)); Banken, M.K. Oklahoma Univ., Norman, OK (United States). 6 Jul 1995. 14p. Sponsored by USDOE, Washington, DC (United States). DOE Contract FC22-93BC14956. Order Number DE95016220. Source: OSTI; NTIS; GPO Dep.

The Oklahoma Geological Survey (OGS), the Geological Information Systems department, and the School of Petroleum and Geological Engineering at the University of Oklahoma are engaging in a program to identify and address Oklahoma's oil recovery opportunities in fluvial-dominated deltaic (FDD) reservoirs. This program includes the systematic and comprehensive collection and evaluation of information on all of Oklahoma's FDD reservoirs and the recovery technologies that have been (or could be) applied to those reservoirs with commercial success. This data collection and evaluation effort will be the foundation for an aggressive, multifaceted technology transfer program that is designed to support all of Oklahoma's oil industry, with particular emphasis on smaller companies and independent operators in their attempts to maximize the economic producibility of FDD reservoirs. Specifically, this project will identify all FDD oil reservoirs in the State; group those reservoirs into plays that have similar depositional and subsequent geologic histories; collect, organize and analyze all available data; conduct characterization and simulation studies on selected reservoirs in each play; and implement a technology transfer program targeted to the operators of FDD reservoirs to sustain the life expectancy of existing wells with the ultimate objective of increasing oil recovery.

28695 (DOE/BC/14956–11) **Identification and evaluation of fluvial-dominated deltaic (Class 1 oil) reservoirs in Oklahoma. Quarterly technical progress report, January 1, 1995–March 31, 1995.** Mankin, C.J. (Oklahoma Geological Survey, Norman, OK (United States)); Banken, M.K. Oklahoma Univ., Norman, OK (United States). 7 Jul 1995. 10p. Sponsored by USDOE, Washington, DC (United States). DOE Contract FC22-93BC14956. Order Number DE95016218. Source: OSTI; NTIS; GPO Dep.

The Oklahoma Geological Survey (OGS), the Geological Information Systems department, and the School of Petroleum and Geological Engineering at the University of Oklahoma are engaging in a program to identify and address Oklahoma's oil recovery opportunities in fluvial-dominated deltaic (FDD) reservoirs. This program includes the systematic and comprehensive collection and evaluation of information on all of Oklahoma's FDD reservoirs and the recovery technologies that have been (or could be) applied to those reservoirs with commercial success. This data collection and evaluation effort will be the foundation for an aggressive, multifaceted technology transfer program that is designed to support all of Oklahoma's oil industry, with particular emphasis on smaller companies and independent operators in their attempts to maximize the economic producibility of FDD reservoirs. Specifically, this project will identify all FDD oil reservoirs in the State; group those reservoirs into plays that have similar depositional and subsequent geologic histories; collect, organize and analyze all available data; conduct characterization and simulation studies on selected reservoirs in each play; and implement a technology transfer program targeted to the operators of FDD reservoirs to sustain the life expectancy of existing wells with the ultimate objective of increasing oil recovery. The elements of the technology transfer program include developing and publishing play portfolios, holding workshops to release play analyses and identify opportunities in each of the plays, and establishing a computer laboratory that is available for industry users.

28696 (DOE/BC/14957–7) **Improved oil recovery in fluvial dominated deltaic reservoirs of Kansas - Near-term. Annual report, June 18, 1993–June 18, 1994.** Green, D.W.; Willhite, G.P. Kansas Univ., Lawrence, KS (United States). Oct 1995. 200p. Sponsored by USDOE, Washington, DC (United States). DOE Contract FC22-93BC14957. Order Number DE95000161. Source: OSTI; NTIS; GPO Dep.

Common oil field problems exist in fluvial dominated deltaic reservoirs in Kansas. The problems are poor waterflood sweep and lack of reservoir management. The poor waterflood sweep efficiency is due to (1) reservoir heterogeneity, (2) channeling of injected water through high permeability zones or fractures, and (3) clogging of water injection wells with solids as a result of poor water quality. In many instances the lack of reservoir management is due to lack of (1) data collection and organization, (2) integrated analysis of existing data by geological and engineering personnel, and (3) identification of optimum recovery techniques. Two demonstration sites operated by different independent oil operators are involved in the project. The Nelson Lease (an existing waterflood) is located in Allen County, Kansas in the N.E. Savonburg Field and is operated by James E. Russell Petroleum, Inc. The Stewart Field (on the latter stage of primary production) is located in Finney County, Kansas and is operated by Sharon Resources, Inc. The objective is to increase recovery efficiency and economics in these type of reservoirs. The technologies being applied to increase waterflood sweep efficiency are (1) in situ permeability modification treatments, (2) infill drilling, (3) pattern changes, and (4) air flotation to improve water quality. The technologies being applied to improve reservoir management are (1) database development, (2) reservoir simulation, (3) transient testing, (4) database management, and (5) integrated geological and engineering analysis.

28697 (DOE/BC/14960–11) **Post waterflood CO_2 miscible flood in light oil fluvial: Dominated deltaic reservoirs. Third quarterly report, April 1, 1995–June 30, 1995.** Texaco Exploration and Production, Inc., New Orleans, LA (United States). 15 Jul 1995. 10p. Sponsored by USDOE, Washington, DC (United States). DOE Contract FC22-93BC14960. Order Number DE96000309. Source: OSTI; NTIS; GPO Dep.

Production from the Marg Area 1 at Port Neches is averaging 337 BOPD for this quarter. The production drop is due to fluctuation in both GOR and BS&W on various producing wells, low water injectivity in the reservoir and shut-in one producing well to perform a workover to replace a failed gravel pack setting. Coil tubing work

was performed on 2 injection wells in order to resume injection of water and CO_2 in the reservoir. The Marg Area 2 did not respond favorably to CO_2 injection in the Kuhn No. 6 well. For this reason Texaco will not pursue any further development of this section of the reservoir due mainly to low target reserves. Instead Texaco will reallocate the money to a new Marg segment (Marg Area 3) in order to test a new process that will utilize the CO_2 to accelerate the primary production rates and reduce cycle time. Also the process should reduce water disposal cost, cash lifting cost, operating cost and increase the NPV of the reserves.

28698 (DOE/BC/14977–6) **Improved efficiency of miscible CO_2 floods and enhanced prospects for CO_2 flooding heterogeneous reservoirs. Annual report, April 14, 1994–April 13, 1995.** Grigg, R.; Heller, J.; Schechter, D. New Mexico Inst. of Mining and Technology, Socorro, NM (United States). Sep 1995. 70p. Sponsored by USDOE, Washington, DC (United States). DOE Contract FG22-94BC14977. Order Number DE95000187. Source: OSTI; NTIS; GPO Dep.

The overall goal of this project is to improve the efficiency of miscible CO_2 floods and enhance the prospects for flooding heterogeneous reservoirs. This objective is being accomplished by extending experimental research in three task areas: (1) foams for selective mobility control in heterogeneous reservoirs, (2) reduction of the amount of CO_2 required in CO_2 floods, and (3) miscible CO_2 flooding in fractured reservoirs. This report provides results of the first year of the three-year project for each of the three task areas.

28699 (DOE/BC/14990–4) **Application of reservoir characterization and advanced technology to improve recovery and economics in a lower quality shallow shelf carbonate reservoir. Quarterly progress report, March 1, 1995–June 30, 1995.** Taylor, A.R. Oxy USA, Inc., Midland, TX (United States). [1995]. 10p. Sponsored by USDOE, Washington, DC (United States). DOE Contract FC22-94BC14990. Order Number DE95017775. Source: OSTI; NTIS; GPO Dep.

West Welch Unit is one of four large waterflood units in the Welch Field located in the Northwestern portion of Dawson County, Texas. The Welch Field was discovered in the early 1940's and produces oil under a solution gas drive mechanism from the San Andres formation at approximately 4800 ft. The field has been under waterflood for 30 years and a significant portion has been infilled drilled on 20-ac density. A 1982–86 pilot CO_2 injection project in the offsetting South Welch Unit yielded positive results.The recent installation of a Co_2 pipeline near the field allowed the phased development of a miscible CO_2 injection project at the South Welch Unit. The reservoir quality is poorer at the West Welch Unit because of its relative location of sea level during deposition. Table I compares reservoir parameters between the two units and shows their ranking in relation to all SSC reservoirs listed in the TORIS database. Because of the proximity of a CO_2 source and the CO_2 operating experience that would be available from the South Welch Unit, West Welch Unit was an ideal location for demonstrating methods for enhancing economics of IOR projects in lower quality SSC reservoirs. This Class 2 project concentrates on the efficient design of a miscible CO_2 project based on detailed reservoir characterization from advanced petrophysics, 3-D seismic interpretations and cross wellbore tomography interpretations.

28700 (DOE/CE/15600–T6) **Method for cutting steam heat losses during cyclic steam injection of wells. Sixth quarterly report.** S-Cal Research Corp., San Rafael, CA (United States). [1995]. 22p. Sponsored by USDOE, Washington, DC (United States). DOE Contract FG49-93CE15600. Order Number DE95016286. Source: OSTI; NTIS; GPO Dep.

Slot-cutting tests were made in a 3.5 in. OD steel pipe representative of the proposed liner of the twin gravel-packed horizontal drainholes used in this Method, for the following purposes: (1)To determine the force required to punch through the liner wall in order to achieve its full penetration with a cutting wheel, (2)To select the most effective profile for the cutting wheel. The results of these tests, made at UC-Berkeley indicated that, with four cutting wheels, as included in the tool design presented in the Fourth Quarterly Report, the total force required was nearly 60,000 lb. In view of the limited tool diameter, the creation of such a large force with a single piston required a hydraulic pressure which would exceed the capability of the Triplex pump, most commonly available in the oil fields. A re-design of the 4-wheel slot-cutting tool with two tandem pistons was done, but revealed a high degree of complexity, related to the difficulty of providing a high-pressure fluid path in the thin housing wall from the hydraulic cylinder above the first pair of arms to a cylinder for the tandem piston located below the first pair of cutter arms and operating the second pair of arms. By reducing the number of cutting wheels from 4 to 3 a single piston driver was sufficient and could result in a tool much simpler to build and to maintain in the Field.The re-designed 3-wheel slot-cutting tool is presented here. It is currently under construction at UC-Berkeley. A second test program will follow, when this simplified modular tool has been assembled. The objective of this second series of tests is to determine the required characteristics of the opposing spring, or Belleville rings stack which, in the new design, is used for retraction of the cutters, rather than for their extension.

28701 (DOE/MC/31197–95/C0472) **Development and testing of underbalanced drilling products.** Maurer, W.; Medley, G. Jr. Maurer Engineering, Inc., Houston, TX (United States). [1995]. 14p. Sponsored by USDOE, Washington, DC (United States). DOE Contract AC21-94MC31197. (CONF-950494–36: Natural gas research, development and demonstration contractors review meeting, Baton Rouge, LA (United States), 4-6 Apr 1995). Order Number DE95014022. Source: OSTI; NTIS; GPO Dep.

The first objective of this project is to develop a user-friendly, PC, foam drilling computer model, FOAM, which will accurately predict frictional pressure drops, cuttings lifting velocity, foam quality, and other drilling variables. The model will allow operating and service companies to accurately predict pressures and flow rates required at the surface and downhole to efficiently drill oil and gas wells with foam systems. The second objective of this project is to develop a lightweight drilling fluid that utilizes hollow glass spheres to reduce the density of the fluid and allow drilling underbalanced in low-pressure reservoirs. Since the resulting fluid will be incompressible, hydraulics calculations are greatly simplified, and expensive air compressors and booster pumps are eliminated. This lightweight fluid will also eliminate corrosion and downhole fire problems encountered with aerated fluids. Many tight-gas reservoirs in the US are attractive targets for underbalanced drilling because they are located in hard-rock country where tight, low-permeability formations compound the effect of formation damage encountered with conventional drilling fluids.

28702 (LBL–37200, pp. 131-136) **FOAM3D: A numerical simulator for mechanistic prediciton of foam displacement in multidimensions.** Kovscek, A.R. (Lawrence Berkeley Laboratory, Berkeley, CA (United States)); Patzek, T.W.; Radke, C.J. Lawrence Berkeley Lab., CA (United States). Mar 1995. DOE Contract AC03-76SF00098. (CONF-9503110–: TOUGH 95: transport of unsaturated ground water and heat workshop, Berkeley, CA (United States), 20-22 Mar 1995). In *Proceedings of the TOUGH Workshop '95 Lawrence Berkeley Laboratory, Berkeley, California, March 20–22, 1995.* 380p. Order Number DE95014788. Source: OSTI; NTIS; GPO Dep.

Field application of foam is a technically viable enhanced oil recovery process (EOR) as demonstrated by recent steam-foam field studies. Traditional gas-displacement processes, such as steam drive, are improved substantially by controlling gas mobility and thereby improving volumetric displacement efficiency. For instance, Patzek and Koinis showed major oil-recovery response after about two years of foam injection in two different pilot studies at the Kern River field. They report increased production of 5.5 to 14% of the original oil in place over a five year period. Because reservoir-scale simulation is a vital component of the engineering and economic evaluation of any EOR project, efficient application of foam as a displacement fluid requires a predictive numerical model of foam displacement. A mechanistic model would also expedite scale-up of the process from the laboratory to the field scale. No general, mechanistic, field-scale model for foam displacement is currently in use.

28703 (NIPER/BDM–0074) **Chemical systems for improved oil recovery: Phase behavior, oil recovery, and mobility control studies.** Llave, F.; Gall, B.; Gao, H., Scott, L., Cook, I. BDM Oklahoma, Inc., Bartlesville, OK (United States). Sep 1995. 65p.

Sponsored by USDOE, Washington, DC (United States). DOE Contract AC22-94PC91008. Order Number DE95000183. Source: OSTI; NTIS; GPO Dep.

Selected surfactant systems containing a series of ethoxylated nonionic surfactants in combination with an anionic surfactant system have been studied to evaluate phase behavior as well as oil recovery potential. These experiments were conducted to evaluate possible improved phase behavior and overall oil recovery potential of mixed surfactant systems over a broad range of conditions. Both polyacrylamide polymers and Xanthan biopolymers were evaluated. Studies were initiated to use a chemical flooding simulation program, UTCHEM, to simulate oil recovery for laboratory and field applications and evaluate its use to simulate oil saturation distributions obtained in CT-monitoring of oil recovery experiments. The phase behavior studies focused on evaluating the effect of anionic-nonionic surfactant proportion on overall phase behavior. Two distinct transition behaviors were observed, depending on the dominant surfactant in the overall system. The first type of transition corresponded to more conventional behavior attributed to nonionic-dominant surfactant systems. This behavior is manifested by an oil-water-surfactant system that inverts from a water-external (highly conducting) microemulsion to an oil-external (nonconducting) one, as a function of temperature. The latter type which inverts in an opposite manner can be attributed to the separation of the anionic-nonionic mixtures into water- and oil-soluble surfactants. Both types of transition behavior can still be used to identify relative proximity to optimal areas. Determining these transition ranges provided more insight on how the behavior of these surfactant mixtures was affected by altering component proportions. Efforts to optimize the chemical system for oil displacement experiments were also undertaken. Phase behavior studies with systems formulated with biopolymer in solution were conducted.

0204 Processing

28704 (BNL–61485) **Bioconversion of heavy crude oils: A basis for new technology.** Premuzic, E.T.; Lin, M.S.; Lian, H. Brookhaven National Lab., Upton, NY (United States). [1995]. 11p. Sponsored by USDOE, Washington, DC (United States). DOE Contract AC02-76CH00016. (CONF-9509173–2: International conference on microbial enhanced oil recovery and related biotechnology for solving environment problems, Dallas, TX (United States), 11-14 Sep 1995). Order Number DE96000432. Source: OSTI; NTIS; GPO Dep.

Systematic studies of chemical mechanisms by which selected microorganisms react with crude oils have led to the identification of biochemical markers characteristic of the interactions of microbes with oils. These biomarkers belong to several groups of natural products ranging from saturate and polyaromatic hydrocarbons containing heterocyclics to organometallic compounds. The biochemical conversions of oils can be monitored by these chemical markers, which are particularly useful in the optimization of biochemical processing, cost efficiency, and engineering studies. Recent results from these studies will be discussed in terms of biochemical technology for the processing of crude oils.

28705 (BNL–61486) **Microbial interactions in crude oils: Possible impact on biochemical versatility on the choice of microbial candidates.** Premuzic, E.T. (and others); Lin, M.S.; Lian, H. Brookhaven National Lab., Upton, NY (United States). [1995]. 27p. Sponsored by USDOE, Washington, DC (United States). DOE Contract AC02-76CH00016. (CONF-9509173–1: International conference on microbial enhanced oil recovery and related biotechnology for solving environment problems, Dallas, TX (United States), 11-14 Sep 1995). Order Number DE96000434. Source: OSTI; NTIS; GPO Dep.

Experimental data gathered over the past several years show that the interactions of microorganisms with crude oils are variable and depend on the microbial species and the chemical composition of crude oils. The variations can be observed in terms of the extent of emulsification, changes in the hydrocarbon composition of crude oils, and duration of biotreatment. All of these factors indicate that the interaction of microbes with crude oils involves multiple chemical reactions resulting from the biochemical interactions between microbes and oils. Different interactions may influence the efficiency of processes in which single or mixed microbial species are used for the oil treatment and may also suggest possible combinations of biological and chemical technologies. Some of these concepts will be discussed in this paper.

28706 (UCRL-JC–120301) **Effects of minerals on the pyrolysis of Kern River 650 F+ residuum.** Reynolds, J.G.; King, K.J. Lawrence Livermore National Lab., CA (United States). Apr 1995. 28p. Sponsored by USDOE, Washington, DC (United States). DOE Contract W-7405-ENG-48. (CONF-950202–2: 6. international conference on heavy crude and tar sands, Houston, TX (United States), 11-18 Feb 1995). Order Number DE96000073. Source: OSTI; NTIS; GPO Dep.

Kern River 650 F+ residuum (Kern Co, CA) and mixtures of Kern River 650 F+ residuum with solids were examined by micropyrolysis at nominal constant heating rates from 1 to 50 C/min from temperatures of 100 to 700 C to establish evolution behavior, pyrolysate yields, and kinetics of evolution. The profiles for all samples generally exhibited two regimes of evolution: (1) low temperature (due to distillation), and (2) high temperature (due to cracking and distillation). The pyrolysate yields of the residuum alone and residuum with solids exhibited, with increasing sample size, a broad maximum at 0.005 to 0.010 g of ~ 1,000 mg pyrolysate/g residuum (relative to Green River oil shale Fischer Assay yield) as well as shifting of distribution from distillation to cracking regime. For kinetic parameters, because much of the low temperature evolving data was due to volatilization and not cracking, determinations were limited mostly to the discrete method. The best fits exhibited very similar parameters for all the samples have principal $E_{discrete}$ of 50 to 51 kcal/mol (accounting for ~30% of total energy) and $A_{discrete}$ around 10^{12} to 10^{13} sec^{-1}. These results indicate the use of heat carriers, such as alumina or dolomite, in pyrolysis processing of heavy oils may effect the overall yields of the pyrolysate, but will probably not effect the pyrolysis cracking rates.

0206 Health and Safety

Refer also to citation(s) 29109

28707 (ANL/EA/CP–86378) **Dose assessment for management alternatives for NORM-contaminated equipment within the petroleum industry.** Blunt, D.L.; Smith, K.P. Argonne National Lab., IL (United States). [1995]. 9p. Sponsored by USDOE, Washington, DC (United States). DOE Contract W-31-109-ENG-38. (CONF-950786–3: 3. annual conference on the recycle and reuse of radioactive scrap metal, Knoxville, TN (United States), 31 Jul - 3 aug 1995). Order Number DE95015829. Source: OSTI; NTIS; GPO Dep.

The contamination of drilling and production equipment by naturally occurring radioactive material (NORM) is a growing concern for the petroleum industry and regulators. Large volumes of NORM-contaminated scrap metal are generated by the industry each year. The contamination generally occurs as surface contamination on the interior of water-handling equipment. The source of this contamination is accumulation of by-product wastes, in the form of scale and sludge contaminated with NORM that are generated by extraction processes. The primary radionuclides of concern in petroleum industry NORM-wastes are radium-226 (Ra-226), and radium-228 (Ra-228). These isotopes are members of the uranium-238 and thorium-232 decay series, respectively. The uranium and thorium isotopes, which are naturally present in the subsurface formations from which hydrocarbons are extracted, are largely immobile and remain in the subsurface. The more soluble radium can become mobilized in the formation water and be transported to the surface in the produced water waste stream. The radium either remains in solution or precipitates in scale or sludge deposits, depending on water salinity and on temperature and pressure phase changes. NORM-containing scale consists of radium that has coprecipitated with barium, calcium, or strontium sulfates, and sludge typically consists of radium-containing silicates and carbonates. This assessment is limited to the evaluation of potential radiological doses from management options that specifically involve recycle and reuse of contaminated metal. Doses from disposal of contaminated equipment are not addressed. Radiological doses were estimated

for workers and the general public for equipment decontamination and smelting. Results of this assessment can be used to examine policy issues concerning the regulation and management of NORM-contaminated wastes generated by the petroleum industry.

0207 Economic, Industrial, and Business Aspects

Refer also to citation(s) 29819

28708 (DOE/EIA–0109(95/09)) **Petroleum supply monthly, September 1995 with data for July 1995.** USDOE Energy Information Administration, Washington, DC (United States). Office of Oil and Gas. 27 Sep 1995. 149p. Sponsored by USDOE, Washington, DC (United States). Order Number DE96000295. Source: OSTI; NTIS; GPO; GPO Dep.

The Petroleum Supply Monthly (PSM) is one of a family of four publications produced by the Petroleum Supply Division within the Energy Information Administration (EIA) reflecting different levels of data timeliness and completeness. The other publications are the Weekly Petroleum Status Report (WPSR), the Winter Fuels Report, and the Petroleum Supply Annual (PSA). Data presented in the PSM describe the supply and disposition of petroleum products in the United States and major US geographic regions. The data series describe production, imports and exports, inter-Petroleum Administration for Defense (PAD) District movements, and inventories by the primary suppliers of petroleum products in the United States (50 States and the District of Columbia). The reporting universe includes those petroleum sectors in primary supply. Included are: petroleum refiners, motor gasoline blenders, operators of natural gas processing plants and fractionators, inter-PAD transporters, importers, and major inventory holders of petroleum products and crude oil. When aggregated, the data reported by these sectors approximately represent the consumption of petroleum products in the United States. Data presented in the PSM are divided into two sections: Summary Statistics and Detailed Statistics.

28709 (DOE/EIA–0380(95/10)) **Petroleum marketing monthly, October 1995 with data for July 1995.** USDOE Energy Information Administration, Washington, DC (United States). Office of Oil and Gas. 3 Oct 1995. 200p. Sponsored by USDOE, Washington, DC (United States). Order Number DE96001051. Source: OSTI; NTIS; GPO; GPO Dep.

The Petroleum Marketing Monthly (PMM) provides information and statistical data on a variety of crude oils and refined petroleum products. The publication presents statistics on crude oil costs and refined petroleum products sales for use by industry, government, private sector analysts, educational institutions, and consumers. Data on crude oil include the domestic first purchase price, the f.o.b. and landed cost Of imported crude oil, and the refiners' acquisition cost of crude oil. Refined petroleum product sales data include motor gasoline, distillates, residuals, aviation fuels, kerosene, and propane. The Petroleum Marketing Division, Office of Oil and Gas, Energy Information Administration ensures the accuracy, quality, and confidentiality of the published data in the Petroleum Marketing Monthly.

28710 (DOE/EIA–0520(95/07)) **International petroleum statistics report.** USDOE Energy Information Administration, Washington, DC (United States). Office of Energy Markets and End Use. 27 Jul 1995. 73p. Sponsored by USDOE, Washington, DC (United States). Order Number DE95015682. Source: OSTI; NTIS; GPO; GPO Dep.

The International Petroleum Statistics Report presents data on international oil production, demand, imports, and exports, and stocks. The report has four sections. Section 1 contains time series data on world oil production, and on oil demand and stocks in the Organization for Economic Cooperation and Development (OECD). This section contains annual data beginning in 1985, and monthly data for the most recent two years. Section 2 presents an oil supply/demand balance for the world. This balance is presented in quarterly intervals for the most recent two years. Section 3 presents data on oil imports by OECD countries. This section contains annual data for the most recent year, quarterly data for the most recent two quarters, and monthly data for the most recent twelve months. Section 4 presents annual time series data on world oil production and oil stocks, demand, and trade in OECD countries. World oil production and OECD demand data are for the years 1970 through 1994; OECD stocks from 1973 through 1994; and OECD trade from 1984 through 1994.

28711 (DOE/EIA–0520(95/09)) **International petroleum statistics report, September 1995.** USDOE Energy Information Administration, Washington, DC (United States). Office of Energy Markets and End Use. Sep 1995. 73p. Sponsored by USDOE, Washington, DC (United States). Order Number DE96001058. Source: OSTI; NTIS; GPO; GPO Dep.

The International Petroleum Statistics Report presents data on international oil production, demand, imports, exports, and stocks. The report has four sections. Section 1 contains time series data on world oil production, and on oil demand and stocks in the Organization for Economic Cooperation and Development (OECD). This section contains annual data beginning in 1985, and monthly data for the most recent two years. Section 2 presents an oil supply/demand balance for the world. This balance is presented in quarterly intervals for the most recent two years. Section 3 presents data on oil imports by OECD countries. This section contains annual data for the most recent year, quarterly data for the most recent two quarters, and monthly data for the most recent twelve months. Section 4 presents annual time series data on world oil production and oil stocks, demand, and trade in OECD countries. World oil production and OECD demand data are for the years 1970 through 1994; OECD stocks from 1973 through 1994; and OECD trade from 1984 through 1994. 4 figs., 45 tabs.

28712 (DOE/EIA–0535(94)) **Fuel oil and kerosene sales 1994.** USDOE Energy Information Administration, Washington, DC (United States). Office of Oil and Gas. 27 Sep 1995. 54p. Sponsored by USDOE, Washington, DC (United States). Order Number DE96001071. Source: OSTI; NTIS; GPO; INIS; GPO Dep.

This publication contains the 1994 survey results of the "Annual Fuel Oil and Kerosene Sales Report" (Form EIA-821). This is the sixth year that the survey data have appeared in a separate publication. Prior to the 1989 report, the statistics appeared in the Petroleum Marketing Annual (PMA)for reference year 1988 and the Petroleum Marketing Monthly (PMM) for reference years 1984 through 1987. The 1994 edition marks the 11th annual presentation of the results of the ongoing "Annual Fuel Oil and Kerosene Sales Report" survey. Distillate and residual fuel oil sales continued to move in opposite directions during 1994. Distillate sales rose for the third year in a row, due to a growing economy. Residual fuel oil sales, on the other hand, declined for the sixth year in a row, due to competitive natural gas prices, and a warmer heating season than in 1993. Distillate fuel oil sales increased 4.4 percent while residual fuel oil sales declined 1.6 percent. Kerosene sales decreased 1.4 percent in 1994.

28713 (DOE/EIA–0538(95/96-01)) **Winter fuels report, week ending October 6, 1995.** USDOE Energy Information Administration, Washington, DC (United States). 6 Oct 1995. 76p. Sponsored by USDOE, Washington, DC (United States). Order Number DE96001133. Source: OSTI; NTIS; GPO Dep.

The Winter Fuels Report is intended to provide concise, timely information to the industry, the press, policymakers, consumers, analysts, and State and local governments on the following topcs: distillate fuel oil net production, imports and stocks on a US level and for all Petroleum Administration for Defense Districts (PADD) and product supplied on a US level; propane net production, imports and stocks on a US level and for PADD's, I, II, and III; natural gas supply and disposition and underground storage for the US and consumption for all PADD's; as well as selected National average prices; residential and wholesale pricing data for heating oil and propane for those States participating in the joint Energy Informatoin Administration (EIA)/State Heating Oil and Propane Program; crude oil and petroleum price comparisons for the US and selected cities; and a 6-10 Day and 30-Day outlook for temperature and precipitation and US total heating degree-days by city.

0208 Waste Management

28714 (ANL/ESD–29) **Assessment of opportunities to increase the recovery and recycling rates of waste oils.** Graziano, D.J.; Daniels, E.J. Argonne National Lab., IL (United States). Aug 1995. 95p. Sponsored by USDOE, Washington, DC (United States). DOE Contract W-31109-ENG-38. Order Number DE96001005. Source: OSTI; NTIS; GPO Dep.

Waste oil represents an important energy resource that, if properly managed and reused, would reduce US dependence on imported fuels. Literature and current practice regarding waste oil generation, regulations, collection, and reuse were reviewed to identify research needs and approaches to increase the recovery and recycling of this resource. The review revealed the need for research to address the following three waste oil challenges: (1) recover and recycle waste oil that is currently disposed of or misused; (2) identify and implement lubricating oil source and loss reduction opportunities; and (3) develop and foster an effective waste oil recycling infrastructure that is based on energy savings, reduced environment at impacts, and competitive economics. The United States could save an estimated 140 x 1012 Btu/yr in energy by meeting these challenges.

28715 (DOE/MT/92009–T2) **Evaluation of the freeze-thaw/evaporation process for the treatment of produced waters. Quarterly technical progress report, April 1–June 31, 1995.** Boysen, J.; Morotti, J. Resource Technology Corp., Laramie, WY (United States). Jul 1995. 7p. Sponsored by USDOE, Washington, DC (United States). DOE Contract AC22-92MT92009. Order Number DE96000937. Source: OSTI; NTIS; GPO Dep.

The cost of treating the water produced in association with oil and natural gas has prevented the completion of wells in economically marginal formations and has caused low-productivity wells to be prematurely shut-in. An economical method for treatment, disposal, and/or reuse of these waters on a commercial-scale would assist the oil and natural gas industries in continuing to provide reasonably priced fuels to the consumer by allowing for economic production from marginal, unconventional, and depleted reserves. A treatment process that could produce water of suitable quality for reuse would also be advantageous for municipal, industrial, and agricultural development in the arid western US where there is significant oil and natural gas production. The natural processes of freezing and evaporation can be coupled to effectively and inexpensively treat waters produced in association with natural gas. This document delineates research conducted, during the time period from 4/1/95 to 6/30/95, for evaluating the technical and economic feasibility of this water treatment process. The research required for development of this process can be completed in two tasks: Task 1–Literature Survey and Preliminary Economic Analysis; Task 2–Laboratory-Scale Process Evaluation and Field Demonstration of the Process. The main work this quarter focused on a re-evaluation of process economics based on lab-scale process simulation results.

0209 Environmental Aspects

Refer also to citation(s) 29836

28716 (ANL/ER-DIS/TM–1) **Test plan for the data acquisition and management system for monitoring the fuel oil spill at the Sandia National Laboratories installation in Livermore, California.** Widing, M.A.; Dominiak, D.M.; Leser, C.C.; Peerenboom, J.P.; Manning, J.F. Argonne National Lab., IL (United States). Apr 1995. 343p. Sponsored by USDOE, Washington, DC (United States). DOE Contract W-31109-ENG-38. Order Number DE95017653. Source: OSTI; NTIS; GPO Dep.

This report describes the formal test plan that will be used for the data acquisition and management system developed to monitor a bioremediation study by Argonne National Laboratory in association with Sandia National Laboratories. The data acquisition and management system will record the site data during the bioremediation and assist experts in site analysis. The three major subsystems of this system are described in detail in this report. In addition, this report documents the component- and system-level test procedures that will be implemented at each phase of the project. Results of these test procedures are documented in this report.

28717 (DOE/MT/92002–11) **Field studies of beach cones as coastal erosion control/reversal devices for areas with significant oil and gas activities. Final report, February 24, 1992–September 18, 1995.** Law, V.J. Tulane Univ., New Orleans, LA (United States). Dept. of Chemical Engineering. 18 Sep 1995. 100p. Sponsored by USDOE, Washington, DC (United States). DOE Contract AC22-92MT92002. Order Number DE96001027. Source: OSTI; NTIS; GPO Dep.

The primary objective of this project was to evaluate the utility of a device called the "beach cone" in combating coastal erosion. Seven initial sites were selected for testing beach cones in a variety of geometric configurations. Permits were obtained from the State of Louisiana and the U.S. Army Corps of Engineers to perform the work associated with this study. Six hundred beach cones were actually installed at six of the sites in late July and early August, 1992. Findings indicate that beach cones accreted significant amounts of materials along the beach of a barrier island, and they might have been instrumental in repairing an approximately 200 meter gap in the island. At the eighth installation the amount of accreted material was measured by surveys to be 2200 cubic meters (2900 cubic yards) in February of 1993, when the cones were found to have been completely covered by the material. At other test sites, accretion rates have been less dramatic but importantly, no significant additional erosion has occurred, which is a positive result. The cost of sediment accretion using beach cones was found to be about $13.72 per cubic yard, which would be much lower if the cones were mass produced (on the order of $3.00 per cubic yard). The survival of the cones through the fringes of Hurricane Andrew indicates that they can be anchored sufficiently to survive significant storms. The measurements of the cones settling rates indicate that this effect is not significant enough to hinder their effectiveness. A subcontract to Xavier University to assess the ecological quality of the experimental sites involved the study of the biogeochemical cycle of trace metals. The highest concentration of heavy metals were near a fishing camp while the lowest levels were in the beach sand of a barrier island. This suggests that the metals do not occur naturally in these areas, but have been placed in the sediments by man's activities.

28718 (EGG–11265-1115) **Habitat reclamation plan to mitigate for the loss of habitat due to oil and gas production activities under maximum efficient rate, Naval Petroleum Reserve No. 1, Kern County, California.** Anderson, D.C. EG and G Energy Measurements, Inc., Las Vegas, NV (United States). Environmental Sciences Div. Nov 1994. 40p. Sponsored by USDOE, Washington, DC (United States). DOE Contract AC08-93NV11265. Order Number DE96000191. Source: OSTI; NTIS; INIS; GPO Dep.

Activities associated with oil and gas development under the Maximum Efficiency Rate (MER) from 1975 to 2025 will disturb approximately 3,354 acres. Based on 1976 aerial photographs and using a dot grid methodology, the amount of land disturbed prior to MER is estimated to be 3,603 acres. Disturbances on Naval Petroleum Reserve No. 1 (NPR-1) were mapped using 1988 aerial photography and a geographical information system. A total of 6,079 acres were classified as disturbed as of June, 1988. The overall objective of this document is to provide specific information relating to the on-site habitat restoration program at NPRC. The specific objectives, which relate to the terms and conditions that must be met by DOE as a means of protecting the San Joaquin kit fox from incidental take are to: (1) determine the amount and location of disturbed lands on NPR-1 and the number of acres disturbed as a result of MER activities, (2) develop a long term (10 year) program to restore an equivalent on-site acres to that lost from prior project-related actions, and (3) examine alternative means to offset kit fox habitat loss.

0220 Transport, Handling, and Storage

28719 (DOE/FE–0340) **Strategic petroleum reserve. Quarterly report.** USDOE Assistant Secretary for Fossil Energy,

Washington, DC (United States). Office of Strategic Petroleum Reserve. 15 Aug 1995. 13p. Sponsored by USDOE, Washington, DC (United States). Order Number DE95017557. Source: OSTI; NTIS; GPO Dep.

The Strategic Petroleum Reserve reduces the Nation's vulnerability to oil supply disruptions. Its existence provides a formidable deterrent to the use of oil as a political instrument and an effective response mechanism should a disruption occur. The Strategic Petroleum Reserve was created pursuant to the Energy Policy and Conservation Act of December 22, 1975 (Public Law 94-163). Its purposes are to reduce the impact of disruptions in supplies of petroleum products and to carry out obligations of the United States under the Agreement on an International Energy Program. Section 165(a) of the Act requires the submission of Annual Reports and Section 165(b)(1) requires the submission of Quarterly Reports. This Quarterly Report highlights activities undertaken during the second quarter of calendar year 1995, including: inventory of petroleum products stored in the Reserve; current and projected storage capacity, analysis of existing or anticipated problems with the acquisition and storage of petroleum products, and future expansion of storage capacity; funds obligated by the Secretary from the SPR Petroleum Account and the Strategic Petroleum Reserve Account during the prior calendar quarter and in total; and major environmental actions completed, in progress, or anticipated.

0230 Properties and Composition

Refer also to citation(s) 28706

0250 Combustion

28720 (BNL–52475) **Proceedings of the 1995 oil heat technology conference and workshop.** McDonald, R.J. Brookhaven National Lab., Upton, NY (United States). Apr 1995. 190p. Sponsored by USDOE. Washington, DC (United States). DOE Contract AC02-76CH00016. (CONF-9503182–: 1995 oil heat technology conference and workshop, Upton, NY (United States), 22-23 Mar 1995). Order Number DE95017560. Source: OSTI; NTIS; GPO Dep.

This report documents the Proceedings of the 1995 Oil Heat Technology Conference and Workshop, held on March 22-23 at Brookhaven National Laboratory (BNL), and sponsored by the U.S. Department of Energy - Office of Building Technologies (DOE-OBT), in cooperation with the Petroleum Marketers Association of America. This Conference, which was the ninth held since 1984, is a key technology transfer activity supported by the ongoing Combustion Equipment Technology (Oil-Heat R&D) program at BNL, and is aimed at providing a forum for the exchange of information among international researchers, engineers, manufacturers, and marketers of oil-fired space-conditioning equipment. The objectives of the Conference were to: (1) Identify and evaluate the state-of-the-art and recommend new initiatives for higher efficiency, a cleaner environment, and to satisfy consumer needs cost-effectively, reliably, and safely; (2) Foster cooperation among federal and industrial representatives with the common goal of sustained national economic growth and energy security via energy conservation. The 1995 Oil Technology Conference comprised: (a) three plenary sessions devoted to presentations and summations by public and private sector industry representatives from the United States, and Canada, and (b) four workshops which focused on mainstream issues in oil-heating technology. Individual reports presented at the conference have been processed separately for database entry.

28721 (BNL–52475, pp. 11-18) **Oil heat technology research and development.** Kweller, E.R. (Department of Energy, Washington, DC (United States)); McDonald, R.J. Brookhaven National Lab., Upton, NY (United States). Apr 1995. (CONF-9503182–: 1995 oil heat technology conference and workshop, Upton, NY (United States), 22-23 Mar 1995). In *Proceedings of the 1995 oil heat technology conference and workshop.* 190p. Order Number DE95017560. Source: OSTI; NTIS.

The purpose of this United States Department of Energy (DOE)/ Brookhaven National Laboratory (BNL) program is to develop a technology base for advancing the state-of-the-art related to oilfired combustion equipment. The major thrust is through technology based research that will seek new knowledge leading to improved designs and equipment optimization. The Combustion Equipment space Conditioning Technology program currently deals exclusively with residential and small commercial building oil heat technology.

28722 (BNL–52475, pp. 19-37) **Rotrix 'vortex breakdown' burner turbulence-stabilized combustion of heating oil.** Hofbauer, P. (Viessmann Manufacturing Co., Inc., Ontario (Canada)). Brookhaven National Lab., Upton, NY (United States). Apr 1995. (CONF-9503182–: 1995 oil heat technology conference and workshop, Upton, NY (United States), 22-23 Mar 1995). In *Proceedings of the 1995 oil heat technology conference and workshop.* 190p. Order Number DE95017560. Source: OSTI; NTIS.

For the past two years, the Viessmann MatriX radiant burner has been setting the standard for low emission combustion of gas. Now, with the RotriX burner, Viessmann has succeeded in drastically reducing nitrogenoxide emissions in the combustoin of oil. After a successful test period, the RotriX burner is now being introduced to the market. The RotriX oil burner consequently takes into account the mechanisms in the creation of harmful emissions in the combustion of heating oil No. 2, and guarantees stable combustion under any operating conditions. The burner has the following features: heating oil is combusted only after complete vaporization and mixing with combustion air and recirculated flue gases; the flame is not stabilized with a turbulator disk, but a strong turbulating current is created by means of the Vortex Breakdown phenomenon, which develops a very stable flame under any operating conditions; and high internal flue gas recirculation rates lower the flame temperature to the point where thermal NO formation is reduced to the same low level as in the combustion of gas. The new burner has extremely low emissions of NOx $<$ 60 mg/ kWh, and CO $<$ 5 mg/kWh at a CO_2 concentraiton of 14%.

28723 (BNL–52475, pp. 39-52) **Canadian R&D on oil-fired integrated systems.** Hayden, A.C.S. (CCRL/ERL/CANMET, Ottawa (Canada)); Entchev, E. Brookhaven National Lab., Upton, NY (United States). Apr 1995. (CONF-9503182–: 1995 oil heat technology conference and workshop, Upton, NY (United States), 22-23 Mar 1995). In *Proceedings of the 1995 oil heat technology conference and workshop.* 190p. Order Number DE95017560. Source: OSTI; NTIS.

This presentation will describe research and development presently being conducted on oil-fired space and water heating systems at the Combustion & Carbonization Research Laboratory (CCRL) in Ottawa, Canada. It will focus on R& D activities at CCRL in support of the Canadian Oil Heat Association (COHA); in particular, progress will be reported on activities to develop suitable oil-fired integrated systems to satisfy the low energy demands of new homes and to define outstanding issues and recommend solutions relating to sidewall venting, particularly in cold climates. Additional activities to be discussed relate to the development of appropriate seasonal efficiency standards for oil-fired combustion systems, in support of Canadian federal and provincial policy initiatives. The first activity in this standards area is a determination of the most appropriate measure of seasonal efficiency of complex integrated space/water heating systems. Performance of a range of existing and prototype integrated systems will be examined and their overall performances defined, using heat loss, heat balance and combined methods, for a wide range of cyclic operations and demands. The draft standard may be either a (slight or detailed) modification of the existing ASHRAE standard, or may be a new more appropriate test and analysis procedure, for the range of present and future systems suitable for Canadian applications in both new, low energy housing and in existing housing. The second standards activity is the development of an appropriate measure for the seasonal efficiency of sidewall vented oil-fired appliances.

28724 (BNL–52475, pp. 53-66) **The application of masonry chimney venting tables for oil-fired appliances.** Krajewski, R.F. (Brookhaven National Lab., Upton, NY (United States)); Strasser, J. Brookhaven National Lab., Upton, NY (United States). Apr 1995. (CONF-9503182–: 1995 oil heat technology conference and workshop, Upton, NY (United States), 22-23 Mar 1995). In *Proceedings of the 1995 oil heat technology conference and workshop.* 190p. Order Number DE95017560. Source: OSTI; NTIS.

This paper presents an overview of the results of work in developing a set of rational guidelines for the venting of modern oil-fired appliances. The activities included the continued development and completion of the Oil-Heat Vent Analysis Program (OHVAP), Version 1.0 and the interpretation of nearly 2,000 runs in preparing recommendations for presentation in table form. These results are presented in the form of venting tables for the installation of chimney vent systems for mid- and high-efficiency oil-fired heating appliances using masonry chimneys. A brief description of OHVAP is given as well as a discussion of what the program does. Recommendations based on the results of OHVAP are presented in the form of five tables spanning oil-fired appliance Steady state Efficiencies (Eff_{ss}) of 80% to 88%. The assumptions used in the calculations and examples of the computed results are presented as well as a discussion of the rationale for masonry chimney system treatment. Working examples are given with suggested diagnostic approaches for application of the table recommendations.

28725 (BNL–52475, pp. 67-77) **The BNL fan-atomized burner system prototype.** Butcher, T.A. (Brookhaven National Lab., Upton, NY (United States)); Celebi, Y. Brookhaven National Lab., Upton, NY (United States). Apr 1995. (CONF-9503182–: 1995 oil heat technology conference and workshop, Upton, NY (United States), 22-23 Mar 1995). In *Proceedings of the 1995 oil heat technology conference and workshop.* 190p. Order Number DE95017560. Source: OSTI; NTIS.

Brookhaven National Laboratory (BNL) has a continuing interest in the development of advanced oil burners which can provide new capabilities not currently available with pressure atomized, retention head burners. Specifically program goals include: the ability to operate at firing rates as low as 0.25 gph; the ability to operate with very low excess air levels for high steady state efficiency and to minimize formation of sulfuric acid and iron sulfate fouling; low emissions of smoke, CO, and NO_x even at very low excess air levels: and the potential for modulation - either staged firing or continuous modulation. In addition any such advanced burner must have production costs which would be sufficiently attractive to allow commercialization. The primary motivation for all work sponsored by the US DOE is, of course, improved efficiency. With existing boiler and furnace models this can be achieved through down-firing and low excess air operation. Also, with low excess air operation fouling and efficiency degradation due to iron-sulfate scale formation are reduced.

28726 (BNL–52475, pp. 79-87) **Field testing the prototype BNL fan-atomized oil burner.** McDonald, R. (Brookhaven National Lab., Upton, NY (United States)); Celebi, Y. Brookhaven National Lab., Upton, NY (United States). Apr 1995. (CONF-9503182–: 1995 oil heat technology conference and workshop, Upton, NY (United States), 22-23 Mar 1995). In *Proceedings of the 1995 oil heat technology conference and workshop.* 190p. Order Number DE95017560. Source: OSTI; NTIS.

BNL has developed a new oil burner design referred to as the Fan Atomized burner System. The primary objective of the field study was to evaluate and demonstrate the reliable operation of the Fan Atomized Burner. The secondary objective was to establish and validate the ability of a low firing rate burner (0.3-0.4 gph) to fully satisfy the heating and domestic hot water load demands of an average household in a climate zone with over 5,000 heating-degree-days. The field activity was also used to evaluate the practicality of side-wall venting with the Fan Atomized Burner with a low stack temperature (300F) and illustrate the potential for very high efficiency with an integrated heating system approach based on the Fan Atomized Burner.

28727 (BNL–52475, pp. 89-104) **Fuel sulfur and boiler fouling.** Litzke, W. (Brookhaven National Lab., Upton, NY (United States)); Celebi, Y.; Butcher, T. Brookhaven National Lab., Upton, NY (United States). Apr 1995. (CONF-9503182–: 1995 oil heat technology conference and workshop, Upton, NY (United States), 22-23 Mar 1995). In *Proceedings of the 1995 oil heat technology conference and workshop.* 190p. Order Number DE95017560. Source: OSTI; NTIS.

Fouling of the heat transfer surfaces of boilers and furnaces by 'soot' leads to reduced efficiency and increased service requirements. The average level of annual efficiency reduction as a result of fouling if generally accepted as 2% per year. Improving the efficiency of equipment in the field may be the most important oil heat conservation opportunity at present. Improvements can be realized by reducing fouling rates, promoting lower firing rates in existing equipment, and enabling excess air levels to be set lower without raising concerns about increased service requirements. In spite of the importance of efficiency in the field there is very little data available on efficiency degradation rates with modern equipment, actual field operating conditions (excess air and smoke number settings) and service problems which affect efficiency. During 1993-94 field tests were initiated to obtain such data and to obtain information that would compliment existing and current laboratory work. Experimental work conducted on a bench scale level have included tests with various advanced burners, fuel types, and different operating conditions which have been done at the BNL Rapid Fouling Test Facility. This report will focus on the field study of fouling effects on ten residential heating service problems at each site are summarized. In addition, the technical difficulties involved with conducting such a field study shall also be discussed as the findings should serve to improve future work in this area.

28728 (BNL–52475, pp. 105-121) **Proper use of sludge-control additives in residential heating oil systems.** Tatnall, R.E. (MIC Associates, Inc., Chadds Ford, PA (United States)). Brookhaven National Lab., Upton, NY (United States). Apr 1995. (CONF-9503182–: 1995 oil heat technology conference and workshop, Upton, NY (United States), 22-23 Mar 1995). In *Proceedings of the 1995 oil heat technology conference and workshop.* 190p. Order Number DE95017560. Source: OSTI; NTIS.

Discussed are various aspects of heating oil 'sludge': How it forms, typical problems it causes, how sludge-control additives work, what should be expected of them, and what happens in a contaminated system when such additives are used. Test results from laboratory and field experiments demonstrate that performance of commercially available additives varies greatly. The concept of 'end-of-the-line' treatment is described and compared with bulk fuel treatment. A procedure is described whereby a retailer can test additives himself, and thus determine just what those additives will or will not do for his business. Finally, the economics of an effective treatment program are outlined.

28729 (BNL–52475, pp. 123-132) **PMAA's national certification program for oil heat technicians.** Allen, D.B. Jr. (E.T. Lawson and Son, Inc., Hampton, VA (United States)). Brookhaven National Lab., Upton, NY (United States). Apr 1995. (CONF-9503182–: 1995 oil heat technology conference and workshop, Upton, NY (United States), 22-23 Mar 1995). In *Proceedings of the 1995 oil heat technology conference and workshop.* 190p. Order Number DE95017560. Source: OSTI; NTIS.

In response to an initiative by Roger McDonald to bring the benefits of Brookhaven National Laboratory's (BNL) research and development to the oil heated homes of America PMAA in conjunction with its member associations has created a voluntary national certification for oil heat technicians. The text which support these programs are the Petroleum Marketers Association of America's (PMAA's) Oil Heat Technician's Manual, and the PMAA's Advanced Oil Heat - A Guide to Improved Efficiency.

28730 (BNL–52475, pp. 133-139) **The Oilheat Manufacturers Associations Oilheat Advantages Project.** Hedden, R. (Oil Heat Management Services, Pawlet, VT (United States)); Bately, J.E. Brookhaven National Lab., Upton, NY (United States). Apr 1995. (CONF-9503182–: 1995 oil heat technology conference and workshop, Upton, NY (United States), 22-23 Mar 1995). In *Proceedings of the 1995 oil heat technology conference and workshop.* 190p. Order Number DE95017560. Source: OSTI; NTIS.

The Oilheat Advantages Project is the Oilheat Manufacturers Association's first project. It involves the creation and disseminaiton of the unified, well documented, compellingly packaged oilheat story. The project invovles three steps: the first step is to pull together all the existing data on the advantages of oilheat into a single, well documented engineering report. The second step will be to rewrite and package the technical document into a consumer piece and a scripted presentation supported with overheads, and to disseminate the information throughout the industry. The third step will be to fund new research to update existing information and discover

new advantages of oilheat. This step will begin next year. The inforamtion will be packaged in the following formats: The Engineering Document. This will include all the technical information including the creditable third party sources for all the findings on the many advantages of oilheat; the Consumer Booklet. This summarizes all the findings in the Engineering Document in simple language with easy to understand illustrations and graphs; a series of single topic Statement Stuffers on each of the advantages; an Overhead Transparency-Supported Scripted Show that can be used by industry representatives for presentations to the general public, schools, civic groups, and service clubs; and the Periodic publication of updates to the Oilheat Advantages Study.

28731 (ETDE/CH-mf–95787322, pp. 51-54) **Double phase-conjugate four-wave mixing of S_2 and OH in flames.** Radi, P. (Paul Scherrer Inst. (PSI), Villigen (Switzerland)); Mischler, B.; Gerber, T. Paul Scherrer Inst. (PSI), Villigen (Switzerland). 1995. In *Paul Scherrer Institut annual report 1994. Annex V: PSI general energy technology newsletter 1994.* 123p. Source: OSTI; NTIS.

An increased use of fuels that contain large quantities of sulfur has stimulated much interest in the gas phase reactions of sulfurous species in flames. However, the picture of the sulfur chemistry in combustion systems is not complete. The proposed reaction mechanisms include several steps that involve S_2 since in a fuel rich environment equilibrium favors the more reduced sulfur species. Consequently, to validate the proposed model, experiments are required that yield concentration profiles of S_2 in flames. In this work, the potential of the Double Phase-Conjugate Four-Wave Mixing (DPCFWM) technique as a diagnostic tool for S_2 in a fuel rich combustion environment is demonstrated. (author) 4 figs., 16 refs.

03 NATURAL GAS

Refer also to citation(s) 29874

0302 Reserves, Geology, and Exploration

Refer also to citation(s) 28685, 28751

28732 (CONF-950572–, pp. 53-75) **Delineation of Piceance Basin basement structures using multiple source data: Implications for fractured reservoir exploration.** Hoak, T.E.; Klawitter, A.L. Alabama Univ., University, AL (United States); Gas Research Inst., Chicago, IL (United States); Environmental Protection Agency, Washington, DC (United States); Mine Safety and Health Administration, Arlington, VA (United States); Alabama Geological Survey, University, AL (United States); USDOE, Washington, DC (United States). [1995]. DOE Contract AC21-93MC30086. From Intergas '95: international unconventional gas symposium; Tuscaloosa, AL (United States); 15-19 May 1995. In *Intergas '95: International unconventional gas symposium. Proceedings.* 576p. Order Number DE95014457. Source: OSTI; NTIS; GPO Dep.

Fractured production trends in Piceance Basin Cretaceous-age Mesaverde Group gas reservoirs are controlled by subsurface structures. Because many of the subsurface structures are controlled by basement fault trends, a new interpretation of basement structure was performed using an integrated interpretation of Landsat Thematic Mapper (TM), side-looking airborne radar (SLAR), high altitude, false color aerial photography, gas and water production data, high-resolution aeromagnetic data, subsurface geologic information, and surficial fracture maps. This new interpretation demonstrates the importance of basement structures on the nucleation and development of overlying structures and associated natural fractures in the hydrocarbon-bearing section. Grand Valley, Parachute, Rulison, Plateau, Shire Gulch, White River Dome, Divide Creek and Wolf Creek fields all produce gas from fractured tight gas sand and coal reservoirs within the Mesaverde Group. Tectonic fracturing involving basement structures is responsible for development of permeability allowing economic production from the reservoirs. In this context, the significance of detecting natural fractures using the intergrated fracture detection technique is critical to developing tight gas resources. Integration of data from widely-available, relatively inexpensive sources such as high-resolution aeromagnetics, remote sensing imagery analysis and regional geologic syntheses provide diagnostic data sets to incorporate into an overall methodology for targeting fractured reservoirs. The ultimate application of this methodology is the development and calibration of a potent exploration tool to predict subsurface fractured reservoirs, and target areas for exploration drilling, and infill and step-out development programs.

28733 (CONF-950572–, pp. 77-95) **Gas-and water-saturated conditions in the Piceance Basin, Western Colorado: Implications for fractured reservoir detection in a gas-centered coal basin.** Hoak, T.E.; Decker, A.D. Alabama Univ., University, AL (United States); Gas Research Inst., Chicago, IL (United States); Environmental Protection Agency, Washington, DC (United States); Mine Safety and Health Administration, Arlington, VA (United States); Alabama Geological Survey, University, AL (United States); USDOE, Washington, DC (United States). [1995]. DOE Contract AC21-93MC30086. From Intergas '95: international unconventional gas symposium; Tuscaloosa, AL (United States); 15-19 May 1995. In *Intergas '95: International unconventional gas symposium. Proceedings.* 576p. Order Number DE95014457. Source: OSTI; NTIS; GPO Dep.

Mesaverde Group reservoirs in the Piceance Basin, Western Colorado contain a large reservoir base. Attempts to exploit this resource base are stymied by iow permeability reservoir conditions. The presence of abundant natural fracture systems throughout this basin, however, does permit economic production. Substantial production is associated with fractured reservoirs in Divide Creek, Piceance Creek, Wolf Creek, White River Dome, Plateau, Shire Gulch, Grand Valley, Parachute and Rulison fields. Successful Piceance Basin gas production requires detailed information about fracture networks and subsurface gas and water distribution in an overall gas-centered basin geometry. Assessment of these three parameters requires an integrated basin analysis incorporating conventional subsurface geology, seismic data, remote sensing imagery analysis, and an analysis of regional tectonics. To delineate the gas-centered basin geometry in the Piceance Basin, a regional cross-section spanning the basin was constructed using hydrocarbon and gamma radiation logs. The resultant hybrid logs were used for stratigraphic correlations in addition to outlining the transbasin gas-saturated conditions. The magnitude of both pressure gradients (paludal and marine intervals) is greater than can be generated by a hydrodynamic model. To investigate the relationships between structure and production, detailed mapping of the basin (top of the Iles Formation) was used to define subtle subsurface structures that control fractured reservoir development. The most productive fields in the basin possess fractured reservoirs. Detailed studies in the Grand Valley-Parachute-Rulison and Shire Gulch-Plateau fields indicate that zones of maximum structural flexure on kilometer-scale structural features are directly related to areas of enhanced production.

28734 (CONF-950572–, pp. 461-476) **Structurally controlled and aligned tight gas reservoir compartmentalization in the San Juan and Piceance Basins.** Decker, A.D.; Kuuskraa, V.A.; Klawitter, A.L. Alabama Univ., University, AL (United States); Gas Research Inst., Chicago, IL (United States); Environmental Protection Agency, Washington, DC (United States); Mine Safety and Health Administration, Arlington, VA (United States); Alabama Geological Survey, University, AL (United States); USDOE, Washington, DC (United States). [1995]. DOE Contract FG03-93ER81502. From Intergas '95: international unconventional gas symposium; Tuscaloosa, AL (United States); 15-19 May 1995. In *Intergas '95: International unconventional gas symposium. Proceedings.* 576p. Order Number DE95014457. Source: OSTI; NTIS; GPO Dep.

Recurrent basement faulting is the primary controlling mechanism for aligning and compartmentalizing upper Cretaceous aged tight gas reservoirs of the San Juan and Piceance Basins. Northwest trending structural lineaments that formed in conjunction with the Uncompahgre Highlands have profoundly influenced sedimentation trends and created boundaries for gas migration; sealing and compartmentalizing sedimentary packages in both basins. Fractures which formed over the structural lineaments provide permeability pathways which allowing gas recovery from otherwise tight gas reservoirs. Structural alignments and associated reservoir

compartments have been accurately targeted by integrating advanced remote sensing imagery, high resolution aeromagnetics, seismic interpretation, stratigraphic mapping and dynamic structural modelling. This unifying methodology is a powerful tool for exploration geologists and is also a systematic approach to tight gas resource assessment in frontier basins.

28735 (DOE/MC/31224–5021) **Naturally fractured tight gas reservoir detection optimization. Quarterly report, January–March 1995.** Coleman Research Corp., Golden, CO (United States). May 1995. 13p. Sponsored by USDOE, Washington, DC (United States). DOE Contract AC21-94MC31224. Order Number DE95009751. Source: OSTI; NTIS; GPO Dep.

The objective is to determine methods for detection and mapping of natural fracture systems for economic production of natural gas from fractured reservoirs. This progress report covers: 3D P-wave survey; additional processing of 3D P-wave survey; review of multicomponent recording feasibility tests; minivibrator studies; and modeling of 3D-3C acquisition parameters.

28736 (LBL–37200, pp. 137-156) **Three-dimensional multiphase effects in aquifer gas storage.** Witherspoon, P.A. (Lawrence Berkeley Laboratory, Berkeley, CA (United States)); Fuller, P.; Finsterle, S. Lawrence Berkeley Lab., CA (United States). Mar 1995. DOE Contract AC03-76SF00098. (CONF-9503110–: TOUGH 95: transport of unsaturated ground water and heat workshop, Berkeley, CA (United States), 20-22 Mar 1995). In *Proceedings of the TOUGH Workshop '95 Lawrence Berkeley Laboratory, Berkeley, California, March 20–22, 1995.* 380p. Order Number DE95014788. Source: OSTI; NTIS; GPO Dep.

The underground storage of natural gas in the United States is one of the most widespread methods of storing energy in the United States. There are two main kinds of storage: (a) dry gas fields, and (b) aquifer storage fields. The storage of gas in dry gas fields involves the conversion of petroleum bearing reservoirs, usually after they have been depleted of any economic production, into a storage operation. An appropriate number of injection-withdrawal (I-W) wells are either drilled or converted from existing exploitation wells, and the storage operations begin by injecting gas to build up to some desired volume of gas in storage.

0303 Drilling, Production, and Processing

Refer also to citation(s) 28688, 28701, 28732, 28733, 28734, 30358

28737 (CONF-950572–, pp. 97-114) **Integrated exploration strategy for locating areas capable of high gas rate cavity completion in coalbed methane reservoirs.** Klawitter, A.L.; Hoak, T.E.; Decker, A.D. Alabama Univ., University, AL (United States); Gas Research Inst., Chicago, IL (United States); Environmental Protection Agency, Washington, DC (United States); Mine Safety and Health Administration, Arlington, VA (United States); Alabama Geological Survey, University, AL (United States); USDOE, Washington, DC (United States). [1995]. DOE Contract FG03-93ER81502. From Intergas '95: international unconventional gas symposium; Tuscaloosa, AL (United States); 15-19 May 1995. In *Intergas '95: International unconventional gas symposium. Proceedings.* 576p. Order Number DE95014457. Source: OSTI; NTIS; GPO Dep.

In 1993, the San Juan Basin accounted for approximately 605 Bcf of the 740 Bcf of all coalbed gas produced in the United States. The San Juan "cavitation fairway" in which production occurs in open-hole cavity completions, is responsible for over 60% of all U.S. coalbed methane production. Perhaps most striking is the fact that over 17,000 wells had penetrated the Fruitland formation in the San Juan Basin prior to recognition of the coalbed methan potential. To understand the dynamic cavity fairway reservoir in the San Juan Basin, an exploration rationale for coalbed methan was developed that permits a sequential reduction in total basin exploration area based on four primary exploration criteria. One of the most significant criterion is the existence of thick, thermally mature, friable coals. A second criterion is the existence of fully gas-charged coals. Evaluation of this criterion requires reservoir geochemical data to delineate zones of meteoric influx where breaching has occurred. A third criterion is the presence of adequate reservoir permeability. Natural fracturing in coals is due to cleating and tectonic processes. Because of the general relationship between coal cleating and coal rank, coal cleating intensity can be estimated by analysis of regional coal rank maps. The final criterion is determining whether natural fractures are open or closed. To make this determination, remote sensing imagery interpretation is supported by ancillary data compiled from regional tectonic studies. Application of these four criteria to the San Juan Basin in a heuristic, stepwise process resulted in an overall 94% reduction in total basin exploration area. Application of the first criterion reduced the total basin exploration area by 80%. Application of the second criterion further winnows this area by an addition 9%. Application of the third criterion reduces the exploration area to 6% of the total original exploration area.

28738 (CONF-950572–, pp. 483-488) **Development and utilization strategies for recovery and utilization of coal mine methane.** Byrer, C.W.; Layne, A.W.; Guthrie, H.D. Alabama Univ., University, AL (United States); Gas Research Inst., Chicago, IL (United States); Environmental Protection Agency, Washington, DC (United States); Mine Safety and Health Administration, Arlington, VA (United States); Alabama Geological Survey, University, AL (United States); USDOE, Washington, DC (United States). [1995]. From Intergas '95: international unconventional gas symposium; Tuscaloosa, AL (United States); 15-19 May 1995. In *Intergas '95: International unconventional gas symposium. Proceedings.* 576p. Order Number DE95014457. Source: OSTI; NTIS; GPO Dep.

The U.S. Department of Energy (DOE), at its Morgantown Energy Technology Center, has been involved in natural gas research since the 1970's. DOE has assessed the potential of gas in coals throughout the U.S. and promoted research and development for recovery and use of methane found in minable and unminable coalbeds. DOE efforts have focused on the use of coal mine methane for regional economic gas self-sufficiency, energy parks, self-help initiatives, and small-power generation. This paper focuses on DOE's past and present efforts to more effectively and efficiently recover and use this valuable domestic energy source. The Climate Change Action Plan (CCAP) (1) lists a series of 50 voluntary initiatives designed to reduce greenhouse gas emissions, such as methane from mining operations, to their 1990 levels. Action No. 36 of the CCAP expands the DOE research, development, and demonstration (RD&D) efforts to broaden the range of cost-effective technologies and practices for recovering methane associated with coal mining operations. The major thrust of Action No. 36 is to reduce methane emissions associated with coal mining operations from target year 2000 levels by 1.5 MMT of carbon equivalent. Crosscutting activities in the DOE Natural Gas Program supply the utilization sectors will address RD&D to reduce methane emissions released from various mining operations, focusing on recovery and end use technology systems to effectively drain, capture, and utilize the emitted gas. Pilot projects with industry partners will develop and test the most effective methods and technology systems for economic recovery and utilization of coal mine gas emissions in regions where industry considers efforts to be presently non-economic. These existing RD&D programs focus on near-term gas recovery and gathering systems, gas upgrading, and power generation.

28739 (CONF-950572–, pp. 489-496) **Recent federal initiatives to promote unconventional gas: High octane delivery of just hot air.** Griff, M.T. Alabama Univ., University, AL (United States); Gas Research Inst., Chicago, IL (United States); Environmental Protection Agency, Washington, DC (United States); Mine Safety and Health Administration, Arlington, VA (United States); Alabama Geological Survey, University, AL (United States); USDOE, Washington, DC (United States). [1995]. From Intergas '95: international unconventional gas symposium; Tuscaloosa, AL (United States); 15-19 May 1995. In *Intergas '95: International unconventional gas symposium. Proceedings.* 576p. Order Number DE95014457. Source: OSTI; NTIS; GPO Dep.

This paper provides an overview of recent initiatives of the United States which promote greater use of natural gas and unconventional gas as one part of this nations's larger response to the global warming threat. Measurable increases in greenhouse

gas concentrations since the beginning of the industrial revolution have led to the belief in the existence of a global warming problem. The international community has responded to the global warming threat with the United Nations Framework Convention on Climate Change which is directed toward the stabilization of greenhouse gases in the atmosphere. The Climate Change Action Plan is the Clinton Administration's detailed response to the global warming threat. It is designed to return United States emissions of greenhouse gases to their 1990 levels by the year 2000. The Action Plan targets all greenhouse gases and emphasizes energy efficiency. Significant regulatory reformation designed to increase the efficiency of the natural gas industry has already occurred and will be continued. Recovery of methane emissions from landfills will be encouraged through indentification of suitable sites and use of existing technology and development of new technology. Recovery of methane from coal mining operations will be promoted by targeting 50 of the gassiest mines in the United States. Even if the Action Plan is fully implemented. legitimate questions arise as to whether its goals will be achieved as a result of funding shortfalls.

28740 (DOE/MC/30088–95/C0474) **High-power slim-hole drilling system.** Cohen, J.H. Maurer Engineering, Inc., Houston, TX (United States). [1995]. 7p. Sponsored by USDOE, Washington, DC (United States). DOE Contract AC21-94MC30088. (CONF-950494–34: Natural gas research, development and demonstration contractors review meeting, Baton Rouge, LA (United States), 4-6 Apr 1995). Order Number DE95014562. Source: OSTI; NTIS; GPO Dep.

The objective of this project is to implement new high-power slim-hole motors and bits into field gas well drilling applications. Development of improved motors and bits is critical because rotating time constitutes the major cost of drilling gas wells. Conventional motors drill most formations 2 to 3 times faster than rotary continuous coring systems due to greater power transfer to the drill bit. New high-power motors and large-cutter TSP bits being developed by Maurer Engineering, Inc. (MEI) drill 2 to 3 times faster than conventional motors. These slim-hole high-power motors and bits, which are ready for field testing on this DOE project, should reduce drilling costs by 20 to 40 percent in many areas. The objective of Phase I is to design, manufacture and laboratory test improved high-power slim-hole motors and large-cutter TSP bits. This work will be done in preparation for Phase II field tests. The objective of Phase II will be to field test the high-power motors and bits in Amoco's Catoosa shallow-test well near Tulsa, OK, and in deep gas wells. The goal will be to drill 2 to 3 times faster than conventional motors and to reduce the drilling costs by 20 to 40 percent over the intervals drilled.

0304 Products and By-Products

28741 (DOE/PC/92110–T9) **Development of vanadium-phosphate catalysts for methanol production by selective oxidation of methane. Quarterly technical progress report 8, January–March, 1995.** McCormick, R.L. Colorado School of Mines, Golden, CO (United States). 25 May 1995. 10p. Sponsored by USDOE, Washington, DC (United States). DOE Contract AC22-92PC92110. Order Number DE96000928. Source: OSTI; NTIS; GPO Dep.

Activities during this quarter focused on fine tuning of catalyst characterization and synthesis techniques. Improvements in catalyst activity test methods were also implemented but more remains to be done. Specific accomplishments include: improved characterization of vanadyl pyrophosphate (VPO) and Si promoted VPO by FTIR and FTIR of chemisorbed bases; several minor improvements in catalyst preparation technique resulting in enhanced catalyst yield, better control of catalyst composition, and generation of less waste; preliminary pulsed reaction data on methane oxidation were also acquired. Preliminary activity measurements for methane conversion (without oxygen) in a pulsed reactor over VPO indicate that the primary reaction product is CO. Carbon dioxide is also formed but selectivity to CO_2 decreases with number of pulses. These results suggest that selectivity to partially oxidized products improves with catalyst reduction and suggest that some surface modification will be required to obtain oxidized hydrocarbon products. Note that catalyst activation (conversion from the precursor to VPO) has been carried out using air. For butane oxidation catalysts VPO is activated in a 1% butane/air mixture which produces a slightly reduced catalyst.

28742 (DOE/PC/92112–T10) **Novel catalysts for methane activation. Quarterly report number 10, January 1–March 31, 1995.** Hirschon, A.S.; Du, Y.; Wu, H.J.; Malhotra, R.; Wilson, R.B. SRI International, Menlo Park, CA (United States). 10 Jun 1995. 13p. Sponsored by USDOE, Washington, DC (United States). DOE Contract AC22-92PC92112. Order Number DE96000929. Source: OSTI; NTIS; GPO Dep.

Fullerenes are a recently discovered allotrope of carbon that possess unusual properties, some of which may be ideal for methane activation. This project is designed to evaluate these carbon-based materials for conversion of methane into higher hydrocarbons. The project is divided into three technical tasks: synthesis and characterization of the fullerenes and fullerene soots; testing of catalysts; and evaluation of the results and technical reporting. The authors had two objectives for this quarter. The first objective was to complete their study of the K-doped fullerene soots to include the selectivity of these materials as a function of methane conversion. The second objective was to identify and evaluate other metal promoters, and the combination of transition and alkali metals to enhance the selectivity of the methane conversion process and hopefully reduce the temperature of reaction. Results from these two tasks are discussed.

28743 (UCRL-CR–110675) **Biomimetic methane oxidation. Final report, October 1, 1989–June 1, 1995.** Watkins, B.E.; Satcher, J.H. Jr.; Droege, M.W.; Taylor, R.T. Lawrence Livermore National Lab., CA (United States). Jul 1995. 97p. Sponsored by USDOE, Washington, DC (United States). DOE Contract W-7405-ENG-48. Order Number DE96000356. Source: OSTI; NTIS; GPO Dep.

Transportation fuels are a critical energy commodity and they impact nearly every sector of this country. The need for transportation fuels is projected well into the next century. Consequently, there is a strong emphasis on the economical conversion of other domestic fossil energy resources to liquid hydrocarbons that can be used as transportation fuels. Natural gas is currently a readily available resource that has a positive future outlook considering its known and anticipated reserves. There is intense government and industrial interest in developing economic technologies to convert natural gas to liquid fuels. Methane, CH_4, is the primary hydrocarbon (85-95%) in natural gas. This document covers the following: production soluable of methane monooxygenase; production of particulate methane monooxygenase; production of methane monooxygenase in continuous culture; subunit resolution for active site identification of methylosinus trichosporium OB3b soluble methane monooxygenase; the synthesis and characterization of new copper coordination complexes contairing the asymmetric coordinating chelate ligand application to enzyme active site modeling; the synthesis and characterization of new iron coordination complexes utilizing an asymmetric coordinating chelate ligand; further characterization of new bionuclear iron complexes.

0305 Health and Safety

28744 (KA-FU–046-93029412) **A Study on the Odorant Mixtures and their Physical Properties.** Choe, K.Y. (Korea Gas Corporation, Ansan (Korea, Republic of)); Shin, S.S. Korea Gas Corp., Ansan (Korea, Republic of). Dec 1994. 185p. (In Korean). Order Number DE96703553. Source: OSTI; NTIS (US Sales Only).

The role of odorization is very important in detecting gas leakage even if the amount is very small (ppm order). In this study, we aim to determine the optimum odorant level of THT, TBM and their mixing ratio in suppling gas of KGC. And we study the physical properties of other mercaptans. Also we find the odor recondition threshold concentration for Koreans. 16 refs., 13 figs., 8 tabs.

28745 (KD-FU–044-93029412) **A Study on the Improvement of Chlorination System.** Choe, K.Y. (Korea Gas Corporation, Ansan (Korea, Republic of)); Ryu, K.C. Korea Gas Corp., Ansan (Korea, Republic of). Dec 1994. 112p. (In Korean). Order Number DE96703552. Source: OSTI; NTIS (US Sales Only).

The Chlorination system is used to protect the seawater eqipments(seawater vaporizing pump, seawater filter, seawater pipes and vaporizer) and prevent the growth of algae in the seawater. To increase the efficiency of evaporation from LNG to NG, the operation of chlorination system is more important. In this study, KGC improves the quality of seawater which we use it as a heat sink. KGC also finds the optimum condition in operating of chlorination system. 27 refs., 18 figs., 20 tabs.

0306 Economic, Industrial, and Business Aspects

Refer also to citation(s) 28713, 28754, 29819

28746 (DOE/EIA–0130(95/08)) **Natural gas monthly, August 1995.** USDOE Energy Information Administration, Washington, DC (United States). Office of Oil and Gas. 24 Aug 1995. 106p. Sponsored by USDOE, Washington, DC (United States). Order Number DE95017407. Source: OSTI; NTIS; GPO; GPO Dep.

The Natural Gas Monthly (NGM) highlights activities, events, and analyses of interest to public and private sector organizations associated with the natural gas industry. Volume and price data are presented each month for natural gas production, distribution, consumption, and interstate pipeline activities. Producer-related activities and underground storage data are also reported. From time to time, the NGM features articles designed to assist readers in using and interpreting natural gas information. This month's feature article is on US Natural Gas Imports and Exports 1994.

28747 (DOE/EIA–0130(95/09)) **Natural gas monthly, September 1995.** USDOE Energy Information Administration, Washington, DC (United States). Office of Oil and Gas. 27 Sep 1995. 112p. Sponsored by USDOE, Washington, DC (United States). Order Number DE96000811. Source: OSTI; NTIS; GPO; GPO Dep.

The (NGM) Natural Gas Monthly highlights activities, events, and analyses of interest to public and private sector organizations associated with the natural gas industry. Volume and price data are presented each month for natural gas production, distribution, consumption, and interstate pipeline activities. Producer-related activities and underground storage data are also reported. From time to time, the NGM features articles designed to assist readers in using and interpreting natural gas information.

28748 (DOE/EP/10050–T8) **Emerging energy security issues: Natural gas in the Gulf Nations, An overview of Middle East resources, export potentials, and markets. Report Series No. 4.** Ripple, R.D.; Hagen, R.E. East-West Center, Honolulu, HI (United States). Sep 1995. 53p. Sponsored by USDOE, Washington, DC (United States). DOE Contract FG01-93EP10050. Order Number DE95017658. Source: OSTI; NTIS; INIS; GPO Dep.

This paper proceeds with a presentation of the natural gas resource base of the Gulf nations of the Middle East. The resource base is put in the context of the world natural gas resource and trade flows. This is followed by a discussion of the existing and planned project to move Gulf natural gas to consuming regions. Then a discussion of the source of demand in the likely target markets for the Gulf resource follows. Next, the nature of LNG pricing is discussed. A brief summary concludes the paper.

28749 (KA-EE–066-94089412) **World natural gas trends and gas projects.** Park, Y.H. (Korea Gas Corporation, Ansan (Korea, Republic of)); Oh, K.J.; Choi, S.S. Korea Gas Corp., Ansan (Korea, Republic of). Dec 1994. 243p. (In Korean). Order Number DE96703555. Source: OSTI; NTIS (US Sales Only).

The study first analyses worldwide supply/demand trends of natural gas. Then it forecasts a high increase in gas demand especially in Asia, and emphasizes the need to secure future supply sources for gas imports. Several issues concerning future gas markets are also addressed, which include: extra growth of natural gas demand due to environmental regulation, pricing issues arising from the efforts of LNG producers to charge for the environment premium of gas, and movements toward new terms and conditions for gas contracts. The study also give detailed descriptions on facts and figures of natural gas industry of Indonesia, Malaysia, Australia, Brunei, Papua New Guinea, Miyanmar and Qatar. 39 refs., 28 figs., 76 tabs.

28750 (KA-EE–067-94089412) **A Preliminary Study for Natural Gas Database System at the R and D Center of Korea Gas Corp.** Park, Y.H. (Korea Gas Corporation, Ansan (Korea, Republic of)); Choi, S.S.; Oh, K.J. Korea Gas Corp., Ansan (Korea, Republic of). Dec 1994. 226p. (In Korean). Order Number DE96703554. Source: OSTI; NTIS (US Sales Only).

There is an urgent need to set up a system of computer facilities at the R and D Center of Korea Gas Corporation, which is to be used for handling energy-related technical information and other general information services. This new system, if installed, will be interacting with the system at the Corporation's head office, as well as with wider networks of information channels, both national and international. This study is a review for selecting a prospective computer system for this purpose. Guidelines in the review were: the system structure will be client/server system, an open system, flexible down sizing and right sizing, and suitable for relational and client-oriented database management system. The review makes recommendation for the Center to build a 3-tier client/server system based on a sun sparc center. 13 refs., 24 figs., 30 tabs.

0307 Waste Management

Refer also to citation(s) 28715, 28762

28751 (DOE/MT/94014–T1) **A study of the relationship of geological formation to the NORM. Quarterly technical progress report, April 1–June 30, 1995.** Bursh, T.P.; Chriss, D. Southern Univ., Baton Rouge, LA (United States). Center for Energy and Environmental Studies. 18 Jul 1995. 4p. Sponsored by USDOE, Washington, DC (United States). DOE Contract FG22-94MT94014. Order Number DE96000939. Source: OSTI; NTIS; GPO Dep.

Naturally Occurring Radioactive Materials (NORM) is a common and costly contaminant of produced waters associated with natural gas production and exploration. One way of combating this problem is by identifying the problem beforehand. The approach to this problem involves development of NORM prediction capabilities based on the geological environment. During the third quarter of this project, emphasis was placed on three tasks; laboratory procedural development, continuance of preliminary geologic data acquisition, and the beginning of field testing of non-produced water sites. Laboratory procedures development included applications of pertinent EPA/Standard Methods, as well as continuing orientation with respect to radiation safety procedures and practices. In terms of progress on the geologic aspects of the project, compilation of relevant well data for the study area is in progress.

0308 Environmental Aspects

Refer also to citation(s) 28718

0320 Transport, Handling, and Storage

Refer also to citation(s) 28736, 28760

28752 (DA-CE–028-92059409) **Corrosion Protection of Sea-Water Pipeline by the Application of Polymer Coating.** Kho, Y.T. (Korea Gas Corporation, Ansan (Korea, Republic of)); Song, H.S.; Park, Y.H.; Min, B.I. Korea Gas Corp., Ansan (Korea, Republic of). Dec 1994. 175p. (In Korean). Order Number DE96703557. Source: OSTI; NTIS (US Sales Only).

Sea-water pipelines are subjected to corrosion problems such as erosion, pitting and crevice corrosion. Either tar-epoxy or rubber coating is factory applied in these pipelines to protect them from corrosion. Impaired coating has resulted in significant corrosion. The objectives of this study are to present a selection criteria for large flow sea water pipelines and to provide informations on the various coating materials commercially a valuable. The coating systems investigated in this study include not only epoxy and tar-epoxy coatings but also fiber reinforced plastic and ultra-violet chosdenable coatings. A part from test resulted, points that showed be noted while arplization and maintanaues of coating are discussed n detail. 7 refs., 24 figs., 10 tabs.

28753 (DA-CR–059-94019412) **Evaluation of cryogenic properties and applicability of 9% nickel steel to large scale liquefied natural gas storage tanks.** Kim, Y.M. (Korea Gas Corporation, Ansan (Korea, Republic of)); Kim, H.S. Korea Gas Corp., Ansan (Korea, Republic of). Dec 1994. 134p. (In Korean). Order Number DE96703547. Source: OSTI; NTIS (US Sales Only).

This work was performed to characterize the critical properties of 9%Ni steel and to evaluate the applicability of 9%Ni steel produced by POSCO for large scale LNG storage tank. In order to assess its applicability to LNG storage tank, brittle fracture initiation and arrest properties of 9%Ni steel plates and their welded joints at the low temperatures were evaluated by means of various fracture toughness test methods such as the crack tip opening displacement, center notched wide plate, double tension, and duplex ESSO tests. Drop weight tear property, fatigue property, Charpy absorbed energy, hardness distribution and harden ability of base plate and/or welded joint were also found to evaluate the integrated fracture behavior and welding characteristics of POSCO 9%Ni steel plate. SMAW, GTAW and SAW methods were applied for these tests of welded joints. Commercial high Ni-alloy type welding materials were used. It was concluded that the steel plates used are good enough to assure the safety of LNG storage tanks from the viewpoints of brittle fracture initiation and arrest, and all the test results satisfy the proposed required values with wide margin. As the results, it is considered that 9%Ni steel plates produced by POSCO have sufficient fracture toughness for the LNG tank and can be applied in a practical use. 21 refs., 63 figs., 31 tabs.

28754 (DOE/MC/31114–95/C0487) **Natural gas storage and end user interaction: A progress report, September 30, 1994–March 31, 1995.** Crook, L.R. Jr.; Reich, S.; Godec, M.L. ICF Resources, Inc., Fairfax, VA (United States). [1995]. 8p. Sponsored by USDOE, Washington, DC (United States). DOE Contract AC21-94MC31114. (CONF-950494–35: Natural gas research, development and demonstration contractors review meeting, Baton Rouge, LA (United States), 4-6 Apr 1995). Order Number DE95014480. Source: OSTI; NTIS; GPO Dep.

In late 1994, ICF Resources began a contract with the Morgantown Energy Technology Center (METC) to conduct a study of natural gas storage and end user interaction. This study is being conducted in three phases: the first phase is an assessment of the market requirements for natural gas storage and in particular to identify those end user requirements for storage that could benefit from METC-sponsored research and development (R&D) in storage technology; the second phase will address the particular technical and economic feasibility for expanding conventional storage; and the third phase will address alternative, unconventional technologies. ICF is approaching the conclusion of the first phase of the study and the second phase has begun. This paper summarizes the scope of the study and reports some of the preliminary findings of the first phase. We begin by providing an overview of the goals of the effort and of natural gas storage. We will address the evolving market requirements for storage and the regulatory and institutional changes that are having a major impact on the use of natural gas storage. We address the demand for storage and the alternatives for meeting this demand, with specific reference to regional and end use issues.

28755 (KA-CE–027-92049403) **Study on optimum repair welding procedure of high pressure open rack vaporizer.** Kho, Y.T. (Korea Gas Corporation, Ansan (Korea, Republic of)); Kim, H.S.; Won, D.S. Korea Gas Corp., Ansan (Korea, Republic of). Apr 1994. 150p. (In Korean). Order Number DE96703558. Source: OSTI; NTIS (US Sales Only).

During the repair work on the open rack vaporizers, tubes are removed from the distributing headers for shop repair. Lots of welding work are required dosing and after repair. Problems associated with welding of vaporizer materials such as A 5086 and A 3083, however, mat result in a significant damage. The objective of this study is to develop an optimum welding procedure of aluminum alloys. Emphasis was pat on the on-site repair welding whose welding condition is worse than shop welding. Unfavorable conditions such as high chumidicty, and narrow working space was taken into account. 33 refs., 40 figs., 22 tabs.

0330 Properties and Composition

28756 (KA-FU–025-92039409) **A Study on the Representative LNG Sampling for Property Measurement.** Choe, K.Y. (Korea Gas Corporation, Ansan (Korea, Republic of)); Ryu, K.C. Korea Gas Corp., Ansan (Korea, Republic of). Sep 1994. 137p. (In Korean). Order Number DE96703551. Source: OSTI; NTIS (US Sales Only).

The calorific value of NG is very important factor for the quality and the price of imported LNG. But it is impossible to measure the composition of total amount of imported LNG. So, KGC uses the sampling method to represent the total amount of imported LNG. This study has three categories. The first is sampling equipments (loading arm, sampling probe, sampling vaporizer, sampling reservoir and compressor etc.). the second is analytical method of NG sample to improve accuracy and repeatability. And the last is systemizing the control process of LNG storage tank to supply natural gas which has constant calorific value. 36 refs., 36 figs., 12 tabs.

28757 (KB-CR–032-92099412) **Analysis of Rollover phenomena and testing research of boil-off on the surface of LNG.** Kim, H. (Korea Gas Corporation, Ansan (Korea, Republic of)); Kim, S.Y.; Sohn, Y.S. Korea Gas Corp., Ansan (Korea, Republic of). Dec 1994. 91p. (In Korean). Order Number DE96703550. Source: OSTI; NTIS (US Sales Only).

When large LNG of different density and temperature id added to a partially filled LNG tank, temporarily stratified layers are present together. As time elapses the subsequent abrupt mixing of the layers leads to a great deal of vaporization on the top layer. It is commonly referred to as LNG rollover phenomena. To prevent such undesirable events, we have numerically calculated the occurrence time of rollover in LNG storage tank at Pyeong Taeg terminal, Korea, with double-diffusive convection model. Here the thermophysical properties of LNG are based on LNG imported from Arun in Indonesia. Especially, the density calculations due to the change of temperature and composition during every computational step are obtained from the more accurate method proposed by Hankinson etc. We can predict the rollover time more effectively and prevent the rollover phenomena in advance. 29 refs., 23 figs., 3 tabs.

28758 (KD-FU–045-93029411) **Research for developing the program(II) of Estimating LNG/NG physical properties.** Kim, H. (Korea Gas Corporation, Ansan (Korea, Republic of)); Kim, S.Y. Korea Gas Corp., Ansan (Korea, Republic of). Dec 1994. 170p. (In Korean). Order Number DE96703548. Source: OSTI; NTIS (US Sales Only).

After liquefied natural gas(LNG) has been imported since 1986 to reduce our national primary energy dependence on petroleum and to give variety utilization, the annual demand of LNG has been getting increased due to its convenience and absence of air pollutants. However, in a shot period of natural gas (NG) usage we still lack the basic physical-thermal data such as density, heat capacity, enthalpy,viscosity and thermal conductivity which could be usually computed on some expensive and unwieldy commercial computer softwares. To overcome these inconveniences we have made here new calculation methods of the basic properties of LNG and NG on personal computer and the results are obtained in shorter running times and correct when compared with those from PRO-II, one of the commercial softwares. 54 refs., 8 figs., 5 tabs.

0340 Combustion

Refer also to citation(s) 28653, 29430, 29978

28759 (DD-GU–024-92119408) **Development of Compressed Natural Gas Fuel Cylinder for Vehicle.** Hong, S.H. (KOrea Gas Corporation, Ansan (Korea, Republic of)); Lee, Y.W.; Yoon, I.S. Korea Gas Corp., Ansan (Korea, Republic of). Aug 1994. 240p. (In Korean). Order Number DE96703549. Source: OSTI; NTIS (US Sales Only).

The outstanding difference of Natural Gas Vehicle(NGV) in comparison with previous one is to load high pressure gas container due to the special characteristics of fuel types. Since natural gas is vapour fuel, it is 4 times volumes of gasoline with the same amount of energy on the conditions of CNG that is pressed to

200bar. As a results, it is filled only quarter time among the same volume of the previous car. The weight of CNG cylinder adds the weight of vehicle in case of loading many cylinder that is cause to shorten vehicle's running distance, so it inevitable that there is the need for ultra light pressure vessel. So, we have developed the composite pressure vessel that is excellent safety, functional superiority, easy to handle. This composite pressure vessel which has 40 liter and 80 liter volume capacity is tested and meet the specification of AGA-NGV2. 22 refs., 36 figs., 21 charts

28760 (DOE/BC/14971–4) **Liquid natural gas as a transportation fuel in the heavy trucking industry. Fourth quarterly progress report, April 1, 1995–June 30, 1995.** Sutton, W.H. Oklahoma Univ., Norman, OK (United States). [1995]. 8p. Sponsored by USDOE, Washington, DC (United States). DOE Contract FG22-94BC14971. Order Number DE95017776. Source: OSTI; NTIS; GPO Dep.

This project encompasses the first year of a proposed three year project with emphasis focused on LNG research issues that may be categorized as direct diesel replacement with LNG fuel, and long term storage/utilization of LNG vent gases produced by tank storage and fueling/handling operation. In addition, a potential new utilization of LNG fuel has been found, as a part of this work on the fundamental nature of adsorption of LNG vent gases in higher hydrocarbons; follow on research for this and other related applications and transfer of technology are proceeding at this time.

28761 (DOE/MT/94011–T1) **Study of the effects of ambient conditions upon the performance of fan powered, infrared, natural gas burners. Quarterly technical progress report, October 1–December 31, 1994.** Bai, T. Clark Atlanta Univ., GA (United States). Jan 1995. 8p. Sponsored by USDOE, Washington, DC (United States). DOE Contract FG22-94MT94011. Order Number DE96000945. Source: OSTI; NTIS; GPO Dep.

The objective of this investigation is to characterize the operation of fan powered infrared (PIR) burner at various barometric pressures (operating altitude) and gas compositions and develop design guidelines for appliances containing PIR burners for satisfactory performance. The fan powered infrared burner is a technology introduced more recently in the residential and commercial markets. It is a surface combustor that elevates the temperature of the burner head to a radiant condition. A variety of metallic and ceramic materials are used for the burner heads. It has been demonstrated that infrared burners produce low CO and NOx emissions in a controlled geometric space. As the environmental regulations become more and more stringent, infrared burners are receiving increasing interests. In this program, the theoretical basis for the behavior of PIR burners will be established through analysis of the combustion, heat and mass transfer, and other related processes that determine the performance of PIR burners. Based on the results of this study, a burner performance model for radiant output will be developed. The model will be applied to predict the performance of the selected burner. The model will also be modified and improved through comparison with experimental results. To conduct experimental study, an experimental setup will be devised and built. This experimental rig will be a modified appliance, capable of measuring the heat and combustion product output, as well as providing a means by which the radiant heat output can be measured. The burner will be selected from an existing commercial appliance that is compatible with the laboratory facilities in the Combustion Laboratory at Clark Atlanta University.

28762 (UCRL-ID–118861) **Numerical simulation of cold flow patterns and turbulent mixing in a simplified burner.** Cloutman, L.D. Lawrence Livermore National Lab., CA (United States). Oct 1994. 28p. Sponsored by USDOE, Washington, DC (United States);California Inst. for Energy Efficiency, Berkeley, CA (United States). DOE Contract W-7405-ENG-48. Order Number DE96000840. Source: OSTI; NTIS; GPO Dep.

The COYOTE computer program was used to simulate the flow field and turbulent mixing near the fuel and air inlets in a simplified burner. The authors report the results of four cold flow calculations that illustrate several interesting phenomena in addition to demonstrating the capabilities of the basic hydrodynamics model and the turbulence model. They also demonstrate some interesting facets of the hydrodynamics of burners. They summarize their findings as follows: (1) two different grids gave vastly different answers, underscoring the importance of assuring grid-independence in numerical solutions; (2) cold flow patterns are much different than reactive flow fields, making it unwise to apply conclusions from the former to the latter; (3) the problem is elliptic, and it is necessary to include the whole furnace in the calculations; (4) the flow patterns exhibited weakly unstable, almost metastable, modes that make it difficult to ascertain when steady conditions have been obtained. The long range goals of this study are to identify parameters that affect the production of NO_x and to discover methods of reducing emissions while maintaining or improving burner efficiency.

05 NUCLEAR FUELS

Refer also to citation(s) 29491, 30329

0501 Reserves, Exploration, and Mining

28763 (IAEA-TECDOC–782) **Spatial data integration for mineral exploration, resource assessment and environmental studies: A guidebook.** International Atomic Energy Agency, Vienna (Austria). Dec 1994. 192p. Order Number DE96602584. Source: OSTI; NTIS (US Sales Only); INIS.

The International Atomic Energy Agency has played a significant role over the years in the improvement and use of uranium exploration techniques and data obtained through uranium exploration. Numerous documents on uranium geology and exploration methods have been published. The purpose of this document is to provide an introduction to the new tools and applications of computer based spatial data integration as used by geologists. In order to provide the experts involved in uranium exploration with information on recent developments in computer applications for spatial data integration and image processing, the IAEA convened consultants meetings in November 1991 and November 1992 to produce this guidebook, which contains information on spatially distributed data, data capture, database creation and visualization of data. Vector, and in particular, raster data types and the aspects of integration modelling are discussed. Refs, figs, tabs, 16 plates.

0504 Feed Processing

28764 (MLM–97) **Process Section progress report, April 1–30, 1948.** Scott, D.L. Monsanto Chemical Co., Dayton, OH (United States). [1948]. 5p. Sponsored by USDOE, Washington, DC (United States). DOE Contract AC04-76DP00053. Order Number DE96001485. Source: OSTI; NTIS; GPO Dep.

The Process group reports that material processing is on schedule and that process laboratories 2 and 3 are being overhauled. The Electrodeposition group reports that they are on schedule but that they are somewhat handicapped due to a lack of coveralls. Administration reports that Site W schedules have been prepared.

0505 Uranium Enrichment

Refer also to citation(s) 30316

0507 Fuels Production and Properties

28765 (INEL–95/0384) **Opportunities for mixed oxide fuel testing in the advanced test reactor to support plutonium disposition.** Terry, W.K. (and others); Ryskamp, J.M.; Sterbentz, J.W. Fermi National Accelerator Lab., Batavia, IL (United States). Aug 1995. 19p. Sponsored by USDOE, Washington, DC (United States). DOE Contract AC07-94ID13223. Order Number DE96001187. Source: OSTI; NTIS; INIS; GPO Dep.

Numerous technical issues must be resolved before LWR operating licenses can be amended to allow the use of MOX fuel. These issues include the following: (1) MOX fuel fabrication process verification; (2) Whether and how to use burnable poisons to depress MOX fuel initial reactivity, which is higher than that of urania; (3) The effects of WGPu isotopic composition; (4) The feasibility of loading MOX fuel with plutonia content up to 7% by weight; (5) The effects of americium and gallium in WGPu; (6) Fission gas release

from MOX fuel pellets made from WGPu; (7) Fuel/cladding gap closure; (8) The effects of power cycling and off-normal events on fuel integrity; (9) Development of radial distributions of burnup and fission products; (10) Power spiking near the interfaces of MOX and urania fuel assemblies; and (11) Fuel performance code validation. The Advanced Test Reactor (ATR) at the Idaho National Engineering Laboratory possesses many advantages for performing tests to resolve most of the issues identified above. We have performed calculations to show that the use of hafnium shrouds can produce spectrum adjustments that will bring the flux spectrum in ATR test loops into a good approximation to the spectrum anticipated in a commercial LWR containing MOX fuel while allowing operation of the test fuel assemblies near their optimum values of linear heat generation rate. The ATR would be a nearly ideal test bed for developing data needed to support applications to license LWRs for operation with MOX fuel made from weapons-grade plutonium. The requirements for planning and implementing a test program in the ATR have been identified. The facilities at Argonne National Laboratory-West can meet all potential needs for pre- and post-irradiation examination that might arise in a MOX fuel qualification program.

28766 (JP–432) **Instructions G.E.I. 34943: Remote mechanical line. Volume 3.** General Electric Co., Schenectady, NY (United States). General Engineering Lab. Apr 1952. 117p. Sponsored by USDOE, Washington, DC (United States). DOE Contract AC06-76RL01830. Order Number DE95012597. Source: OSTI; NTIS; GPO Dep.

This document, Volume 3, describes how the wet chemical operations are performed to convert the nitrate solution to an oxalate precipitate. The supernate is then decanted from the vessel and the remaining slurry containing the precipitate is transferred to a boat for the Dry Chemistry operations.

28767 (LA–12996-MS) **Synthesis of uranium metal using laser-initiated reduction of uranium tetrafluoride by calcium metal.** West, M.H.; Martinez, M.M.; Nielsen, J.B.; Court, D.C.; Appert, Q.D. Los Alamos National Lab., NM (United States). Sep 1995. 11p. Sponsored by USDOE, Washington, DC (United States). DOE Contract W-7405-ENG-36. Order Number DE96000059. Source: OSTI; NTIS; INIS; GPO Dep.

Uranium metal has numerous uses in conventional weapons (armor penetrators) and nuclear weapons. It also has application to nuclear reactor designs utilizing metallic fuels–for example, the former Integral Fast Reactor program at Argonne National Laboratory. Uranium metal also has promise as a material of construction for spent-nuclear-fuel storage casks. A new avenue for the production of uranium metal is presented that offers several advantages over existing technology. A carbon dioxide (CO_2) laser is used to initiate the reaction between uranium tetrafluoride (UF_4) and calcium metal. The new method does not require induction heating of a closed system (a pressure vessel) nor does it utilize iodine (I_2) as a chemical booster. The results of five reductions of UF_4, spanning 100 to 200 g of uranium, are evaluated, and suggestions are made for future work in this area.

0508 Spent Fuels Reprocessing

Refer also to citation(s) 28842, 28843, 28849

28768 (INIS-mf–14561, pp. 61-68) **Preparation of TRU fuel and target materials for the transmutation of actinides by gel co-conversion.** Ingold, F. (Paul Scherrer Inst. (PSI), Villigen (Switzerland)); Ledergerber, G. [1995]. 125p. In *Paul Scherrer Institut annual report 1994. Annex IV: PSI nuclear energy and safety research progress report 1994.* Order Number DE96601628.

In the fabrication of fuel containing transuranium (TRU) elements, flow sheets and techniques that allow a shielded and/or remote fabrication will probably need to be applied. One approach, which has been demonstrated on the laboratory and semi prototype scale, is the wet fabrication route of co-precipitation of the matrix element uranium and plutonium to form either dense spherical particles or to produce hybrid pellets made from pressed gel microspheres. The ceramic material produced holds the TRU-elements (Pu, Np, Am) homogeneously distributed in the matrix. In conjunction with the Department d'Etudes des Combustibles of the French Commissariat a l'Energie Atomique (CEA-DEC) in Cadarache, PSI is further developing a mixed nitride ceramic and mixed oxide with high concentrations (up to 50%) of plutonium with the aim of a joint irradiation test of transuranium elements in the French PHENIX reactor. (author) 2 figs., 3 tabs., 16 refs.

28769 (INIS-mf–14591) **Qualitative chemical analysis of plutonium by Alpha spectroscopy.** Ramirez G, J Qumica.J. Universidad Veracruzana, Jalapa (Mexico). Facultad de Ingenieria Quimica. 1994. 48p. (In Spanish). Order Number DE96602534. Source: OSTI; NTIS (US Sales Only); INIS.

In this work the separation and purification of plutonium from irradiated uranium was done. The plutonium, produced by the irradiation of uranium in a nuclear reactor and the β decay of ^{239}Np, was stabilized to Pu $^{+4}$ with sodium nitrite. Plutonium was separated from the fission products and uranium by ion exchange using the resin Ag 1 X 8. It was electrodeposited on stainless steel discs and the alpha radioactivity of plutonium was measured in a surface barrier detector. The results showed that plutonium was separated with a radiochemical purity higher than 99 %. (Author).

28770 (LA-UR–95-17922, pp. 627-637) **Brief overview of the long-lived radionuclide separation processes developed in France in connection with the SPIN program.** Madic, C. (DRDD, Fontenay-aux-Roses (France)); Bourges, J.; Dozol, J.F. Los Alamos National Lab., NM (United States). [1995]. Contract F12W-CT-0112; Contract F12W-CT-90-0062. (CONF-9407103–: International conference on accelerator-driven transmutation technologies and applications, Las Vegas, NV (United States), 25 Jul - 1 aug 1994). In *AIP conference on accelerator driven transmutation technologies and applications, Los Vegas, Nevada, July 25-29, 1994.* 958p. Order Number DE95014018. Source: OSTI; NTIS; INIS.

To reduce the long-term potential hazards associated with the management of nuclear wastes generated by nuclear fuel reprocessing, one alternative is the transmutation of long-lived radionuclides into short-lived radionuclides by nuclear means (P & T strategy). In this context, according to the law passed by the French Parliament on 30 December 1991, the CEA launched the SPIN program for the design of long-lived radionuclide separation and nuclear incineration processes. The research in progress to define separation processes focused mainly on the minor actinides (neptunium, americium and curium) and some fission products, like cesium and technetium. To separate these long-lived radionuclides, two strategies were developed. The first involves research on new operating conditions for improving the PUREX fuel reprocessing technology. This approach concerns the elements neptunium and technetium (iodine and zirconium can also be considered). The second strategy involves the design of new processes; DIAMEX for the co-extraction of minor actinides from the high-level liquid waste leaving the PUREX process, An(III)/Ln(III) separation using tripyridyltriazine derivatives or picolinamide extracting agents; SESAME for the selective separation of americium after its oxidation to Am(IV) or Am(VI) in the presence of a heteropolytungstate ligand, and Cs extraction using a new class of extracting agents, calixarenes, which exhibit exceptional Cs separation properties, especially in the presence of sodium ion. This lecture focuses on the latest achievements in these research areas.

28771 (LA-UR–95-17922, pp. 638-644) **Electrochemical separation of actinides and fission products in molten salt electrolyte.** Gay, R.L. (Rockwell International/Rocketdyne Division, Canoga Park, CA (United States)); Grantham, L.F.; Fusselman, S.P. Los Alamos National Lab., NM (United States). [1995]. (CONF-9407103–: International conference on accelerator-driven transmutation technologies and applications, Las Vegas, NV (United States), 25 Jul - 1 aug 1994). In *AIP conference on accelerator driven transmutation technologies and applications, Los Vegas, Nevada, July 25-29, 1994.* 958p. Order Number DE95014018. Source: OSTI; NTIS; INIS.

Molten salt electrochemical separation may be applied to accelerator-based conversion (ABC) and transmutation systems by dissolving the fluoride transport salt in LiCl-KCl eutectic solvent. The resulting fluoride-chloride mixture will contain small concentrations of fission product rare earths (La, Nd, Gd, Pr, Ce, Eu, Sm,

and Y) and actinides (U, Np, Pu, Am, and Cm). The Gibbs free energies of formation of the metal chlorides are grouped advantageously such that the actinides can be deposited on a solid cathode with the majority of the rare earths remaining in the electrolyte. Thus, the actinides are recycled for further transmutation. Rockwell and its partners have measured the thermodynamic properties of the metal chlorides of interest (rare earths and actinides) and demonstrated separation of actinides from rare earths in laboratory studies. A model is being developed to predict the performance of a commercial electrochemical cell for separations starting with PUREX compositions. This model predicts excellent separation of plutonium and other actinides from the rare earths in metal-salt systems.

28772 (LA-UR–95-17922, pp. 652) **Lithium actinide recycle process demonstration.** Johnson, G.K. (Argonne National Laboratory, IL (United States)); Pierce, R.D.; McPheeters, C.C. Los Alamos National Lab., NM (United States). [1995]. (CONF-9407103–: International conference on accelerator-driven transmutation technologies and applications, Las Vegas, NV (United States), 25 Jul - 1 aug 1994). In *AIP conference on accelerator driven transmutation technologies and applications, Los Vegas, Nevada, July 25-29, 1994*. 958p. Order Number DE95014018. Source: OSTI; NTIS; INIS.

Several pyrochemical processes have been developed in the Chemical Technology Division of Argonne Laboratory for recovery of actinide elements from LWR spent fuel. The lithium process was selected as the reference process from among the options. In this process the LWR oxide spent fuel is reduced by lithium at 650°C in the presence of molten LiCl. The Li_2O formed during the reduction process is soluble in the salt. The spent salt and lithium are recycled after the Li_2O is electrochemically reduced. The oxygen is liberated as CO_2 at a carbon anode or oxygen at an inert anode. The reduced metal components of the LWR spent fuel are separated from the LiCL salt phase and introduced into an electrorefiner. The electrorefining step separates the uranium and transuranium (TRU) elements into two product streams. The uranium product, which comprises about 96% of the LWR spent fuel mass, may be enriched for recycle into the LWR fuel cycle, stored for future use in breeder reactors, or converted to a suitable form for disposal as waste. The TRU product can be recycled as fast reactor fuel or can be alloyed with constituents of the LWR cladding material to produce a stable waste form.

28773 (LA-UR–95-17922, pp. 783) **Chemistry of pyroprocessing for nuclear waste transmutation.** Ackerman, J.P. (Argonne National Laboratory, IL (United States)). Los Alamos National Lab., NM (United States). [1995]. (CONF-9407103–: International conference on accelerator-driven transmutation technologies and applications, Las Vegas, NV (United States), 25 Jul - 1 aug 1994). In *AIP conference on accelerator driven transmutation technologies and applications, Los Vegas, Nevada, July 25-29, 1994*. 958p. Order Number DE95014018. Source: OSTI; NTIS; INIS.

Pyrochemical treatment of spent nuclear fuel is an attractive approach for separating the transuranium (TRU) elements neptunium, plutonium, americium, and curium because of its simplicity, diversion resistance, and potentially low cost.

28774 (SAND–95-1990C) **Burnup verification measurements at U.S. Nuclear Facilities using the Fork system.** Ewing, R.I. Sandia National Labs., Albuquerque, NM (United States). [1995]. 10p. Sponsored by USDOE, Washington, DC (United States);Electric Power Research Inst., Palo Alto, CA (United States). DOE Contract AC04-94AL85000. (CONF-9509100–29: 5. international conference on nuclear criticality safety, Albuquerque, NM (United States), 17-22 Sep 1995). Order Number DE95017884. Source: OSTI; NTIS; INIS; GPO Dep.

Burnup verification measurements have been performed using the Fork system at the Oconee Nuclear Station of Duke Power Company, and at Arkansas Nuclear One (Units 1 and 2), operated by Energy Operations, Inc. Passive neutron and gamma-ray measurements on individual spent fuel assemblies were correlated with the reactor records for burnup, cooling time, and initial enrichment. The correlation generates an internal calibration for the system in the form of a power law determined by a least squares fit to the neutron data. The average deviation of the reactor burnup records from the calibration determined from the measurements is a measure of the random error in the burnup records. The observed average deviations ranged from 2.2% to 3.5% for assemblies at the three reactor sites, indicating a high degree of consistency in the reactor records. Anomalous measurements were also observed, but could be explained by the presence of neutron sources in the assemblies. The effectiveness of the Fork system for verification of reactor records is due to the sensitivity of the neutron yield to burnup, the self-calibration generated by a series of measurements, the redundancy provided by three independent detection systems, and the operational simplicity and flexibility of the design.

0509 Transport, Handling, and Storage

Refer also to citation(s) 28791, 28793, 28795, 28800, 28836, 28840, 29088, 29119, 29146, 29153, 29828, 30235

28775 (DOE/EM–0258) **The transportation external coordination working group.** USDOE Office of Environmental Restoration and Waste Management, Washington, DC (United States). 1995. 2p. Sponsored by USDOE, Washington, DC (United States). Order Number DE96000262. Source: OSTI; NTIS; GPO Dep.

In an effort to improve coordinated interactions between the United States Department of Energy (DOE) and external groups interested in transportation activities, DOE established the Transportation External Coordination Working Group (TEC/WG). Membership includes representatives from State, Tribal and local governments, industry, and professional organizations. All DOE programs with significant transportation programs participate.

28776 (DOE/ID–10511) **Validation of the transportation computer codes HIGHWAY, INTERLINE, RADTRAN 4, and RISKIND.** Maheras, S.J.; Pippen, H.K. Science Applications International Corp., Idaho Falls, ID (United States). May 1995. 370p. Sponsored by USDOE, Washington, DC (United States). DOE Contract AC07-92ID13208. Order Number DE96001332. Source: OSTI; NTIS; INIS; GPO Dep.

The computer codes HIGHWAY, INTERLINE, RADTRAN 4, and RISKIND were used to estimate radiation doses from the transportation of radioactive material in the Department of Energy Programmatic Spent Nuclear Fuel Management and Idaho National Engineering Laboratory Environmental Restoration and Waste Management Programs Environmental Impact Statement. HIGHWAY and INTERLINE were used to estimate transportation routes for truck and rail shipments, respectively. RADTRAN 4 was used to estimate collective doses from incident-free transportation and the risk (probability x consequence) from transportation accidents. RISKIND was used to estimate incident-free radiation doses for maximally exposed individuals and the consequences from reasonably foreseeable transportation accidents. The purpose of this analysis is to validate the estimates made by these computer codes; critiques of the conceptual models used in RADTRAN 4 are also discussed. Validation is defined as "the test and evaluation of the completed software to ensure compliance with software requirements." In this analysis, validation means that the differences between the estimates generated by these codes and independent observations are small (i.e., within the acceptance criterion established for the validation analysis). In some cases, the independent observations used in the validation were measurements; in other cases, the independent observations used in the validation analysis were generated using hand calculations. The results of the validation analyses performed for HIGHWAY, INTERLINE, RADTRAN 4, and RISKIND show that the differences between the estimates generated using the computer codes and independent observations were small. Based on the acceptance criterion established for the validation analyses, the codes yielded acceptable results; in all cases the estimates met the requirements for successful validation.

28777 (DOE/LLW–192) **Greater-Than-Class C Low-Level Radioactive Waste Transportation Strategy report and institutional plan.** Schmitt, R.C.; Tyacke, M.J. Lockheed Idaho Technologies Co., Idaho Falls, ID (United States). Jan 1995. 40p. Sponsored by USDOE, Washington, DC (United States). DOE

Contract AC07-94ID13223. Order Number DE95017651. Source: OSTI; NTIS; INIS; GPO Dep.

This document contains two parts. Part I, Greater-Than-Class-C Low-Level Radioactive Waste Transportation Strategy, addresses the requirements, responsibilities, and strategy to transport and receive these wastes. The strategy covers (a) transportation packaging, which includes shipping casks and waste containers; (b) transportation operations relating to the five facilities involved in transportation, i.e., waste originator, interim storage, dedicated storage, treatment, and disposal; (c) system safety and risk analysis; (d) routes; (e) emergency preparedness and response; and (o safeguards and security. A summary of strategic actions is provided at the conclusion of Part 1. Part II, Institutional Plan for Greater-Than-Class C Low-Level Radioactive Waste Packaging and Transportation, addresses the assumptions, requirements, and institutional plan elements and actions. As documented in the Strategy and Institutional Plan, the most challenging issues facing the GTCC LLW Program shipping campaign are institutional issues closely related to the strategy. How the Program addresses those issues and demonstrates to the states, local governments, and private citizens that the shipments can and will be made safely will strongly affect the success or failure of the campaign.

28778 (DOE/RL–95-43) **Needs assessment activity report: April 1995.** USDOE Assistant Secretary for Environmental Management, Washington, DC (United States). Apr 1995. 28p. Sponsored by USDOE, Washington, DC (United States). DOE Contract AC06-87RL10930. Order Number DE96000683. Source: OSTI; NTIS; INIS; GPO Dep.

As part of a US Department of Energy Headquarters task (DOE-HQ), the Packaging Operations and Development Group within Westinghouse Hanford Company (WHC) has assessed the packaging needs of many DOE sites. These assessments have involved site visits and meetings with personnel involved with transportation and packaging of hazardous materials. By March 1995, 20 DOE facilities had been visited. As a result, these sites been informed of some of the packaging activities that DOE has sponsored and is sponsoring, have been apprised of the affects of upcoming changes to transportation regulations, have discussed their short-term packaging needs, and have shared unique packaging they have developed which may be of use to other DOE facilities. Program successes include discovery of a need for a reusable Type A liquid sample packaging and its development within another DOE task, establishing communications pathways between DOE sites that have similar transportation and packaging needs, and starting to establish a centralized packaging clearinghouse that will coordinate DOE Complex needs and improve the cost-effectiveness of transportation and packaging activities.

28779 (INEL–95/0167) **Conceptual design report for a transportable DUCRETE spent fuel storage cask system.** Hopf, J.E. (Sierra Nuclear Corp., Scotts Valley, CA (United States)). Lockheed Idaho Technologies Co., Idaho Falls, ID (United States). Aug 1995. 71p. Sponsored by USDOE, Washington, DC (United States). DOE Contract AC07-94ID13223. Order Number DE95017516. Source: OSTI; NTIS; INIS; GPO Dep.

A conceptual design has been developed for a spent fuel dry storage cask that employs depleted uranium concrete (DUCRETE) in place of ordinary concrete. DUCRETE, which uses depleted uranium oxide rocks rather than gravel as the concrete's heavy aggregate, is a more efficient overall radiation shield (gamma and neutron) than either steel or ordinary concrete. Thus, it allows the cask weight and size to be substantially reduced. Also, using DUCRETE as shielding avoids, or at least defers, disposal of the depleted uranium as waste. This report focuses on DUCRETE cask transportation issues. The approach studied involves placing the storage cask into a simple steel transportation overpack. Preliminary analyses were performed to demonstrate the transportation system's ability to meet the structural, thermal, and shielding transportation criteria. Conservative manual calculations were performed to demonstrate the adequacy of the DUCRETE transportation overpack with respect to structural requirements. Two-dimensional thermal analyses were performed on the system (the DUCRETE storage cask inside the steel overpack) using the ANSYS thermal analysis code. Two-dimensional shielding analyses were performed on the system with the MCNP code. Effects of the fuel axial burnup profile and solar radiation are considered. The analyses show that the proposed system can meet the transportation structural criteria and can easily meet the transportation shielding criteria. The thermal criteria are not as easy to meet because when the storage cask is placed horizontally in the transportation overpack, the DUCRETE storage cask's ventilation duct becomes an insulating dead air space. The maximum allowable temperature for the DUCRETE, which is not yet known, will be the limiting factor.

28780 (ORNL/SUB–86-97393/6) **Facility Interface Capability Assessment (FICA) project report.** Pope, R.B. (ed.) (Oak Ridge National Lab., TN (United States)); MacDonald, R.R. (ed.); Viebrock, J.M.; Mote, N. Oak Ridge National Lab., TN (United States); Nuclear Assurance Corp., Norcross, GA (United States). Sep 1995. 120p. Sponsored by USDOE, Washington, DC (United States). DOE Contract AC05-84OR21400 ; AC01-91RW00134. Order Number DE96001001. Source: OSTI; NTIS; INIS; GPO Dep.

The US Department of Energy's (DOE) Office of Civilian Radioactive Waste Management (OCRWM) is responsible for developing the Civilian Radioactive Waste Management System (CRWMS) to accept spent nuclear fuel from commercial facilities. The objective of the Facility Interface Capability Assessment (FICA) project was to assess the capability of each commercial spent nuclear fuel (SNF) storage facility, at which SNF is stored, to handle various SNF shipping casks. The purpose of this report is to present and analyze the results of the facility assessments completed within the FICA project. During Phase 1, the data items required to complete the facility assessments were identified and the database for the project was created. During Phase 2, visits were made to 122 facilities on 76 sites to collect data and information, the database was updated, and assessments of the cask-handling capabilities at each facility were performed. Each assessment of cask-handling capability contains three parts: the current capability of the facility (planning base); the potential enhanced capability if revisions were made to the facility licensing and/or administrative controls; and the potential enhanced capability if limited physical modifications were made to the facility. The main conclusion derived from the planning base assessments is that the current facility capabilities will not allow handling of any of the FICA Casks at 49 of the 122 facilities evaluated. However, consideration of potential revisions and/or modifications showed that all but one of the 49 facilities could be adapted to handle at least one of the FICA Casks. For this to be possible, facility licensing, administrative controls, and/or physical aspects of the facility would need to be modified.

28781 (ORNL/SUB–86-97393/8) **Facility Interface Capability Assessment (FICA) user manual.** Pope, R.B. (ed.) (Oak Ridge National Lab., TN (United States)); MacDonald, R.R. (ed.); Massaglia, J.L.; Williamson, D.A.; Viebrock, J.M.; Mote, N. Oak Ridge National Lab., TN (United States); Civilian Radioactive Waste Management System, Vienna, VA (United States); Nuclear Assurance Corp., Norcross, GA (United States). Sep 1995. 120p. Sponsored by USDOE, Washington, DC (United States). DOE Contract AC05-84OR21400 ; AC01-91RW00134. Order Number DE96000775. Source: OSTI; NTIS; INIS; GPO Dep.

The US Department of Energy's (DOE) Office of Civilian Radioactive Waste Management (OCRWM) is responsible for developing the Civilian Radioactive Waste Management System (CRWMS) to accept spent nuclear fuel from commercial facilities. The objective of the Facility Interface Capability Assessment (FICA) project was to assess the capability of each commercial spent nuclear fuel (SNF) storage facility, at which SNF is stored, to handle various SNF shipping casks. The purpose of this report is describe the FICA computer software and to provide the FICA user with a guide on how to use the FICA system. The FICA computer software consists of two executable programs: the FICA Reactor Report program and the FICA Summary Report program (written in the Ca-Clipper version 5.2 development system). The complete FICA software system is contained on either a 3.5 in. (double density) or a 5.25 in. (high density) diskette and consists of the two FICA programs and all the database files (generated using dBASE III). The FICA programs are provided as "stand alone" systems and neither the Ca-Clipper compiler nor dBASE III is required to run the FICA programs. The steps for installing the FICA software system

and executing the FICA programs are described in this report. Instructions are given on how to install the FICA software system onto the hard drive of the PC and how to execute the FICA programs from the FICA subdirectory on the hard drive. Both FICA programs are menu driven with the up-arrow and down-arrow keys used to move the cursor to the desired selection.

28782 (UCRL-ID–117333) **Historical review of plutonium storage container failures at Lawrence Livermore National Laboratory.** Dodson, K.E. Lawrence Livermore National Lab., CA (United States). May 1994. 15p. Sponsored by USDOE, Washington, DC (United States). DOE Contract W-7405-ENG-48. Order Number DE95017263. Source: OSTI; NTIS; GPO Dep.

As part of the DOE Plutonium Vulnerability Assessment, an investigation was made to characterize the can failures at LLNL. Since the LLNL Plutonium Facility was opened for plutonium operations in 1961, there have only been three can failures that could be remembered by plutonium handlers, vault workers, chemical analysts, and material managers. Only one of these can failures was discovered during the processing of more than 606 packages containing plutonium as part of the LLNL Plutonium Inventory Reduction Program. A very low failure rate, especially since some of the 606 cans had been in storage for two to three decades. Two of the three containers that failed were made of aluminum and were packaged with 1.25 inch diameter plutonium metal spheres. The cans were split down their entire length and the plutonium metal was heavily oxidized. The secondary gallon container of the third package failure was found to be imploded in the storage vault. Upon closer examination, the plastic bags around the inner pint can were badly melted and the lid on the can was loose. Like the other two failures, the metal was heavily oxidized. In all three of the can failures, it is theorized that air entered the inner can through incomplete sealing and the oxygen in the air then reacted with the plutonium metal to produce plutonium oxide. Air was supplied to the inner can by permeation through the surrounding plastic bag. The air could have either diffused through the bag or could have been pumped through the twisted and taped ends of the inner most bag. The inner bags and cans were packaged into second bags and cans in an air atmosphere; therefore, trapping air inside the packaging configuration that could have passed through the bags. A failure of the inner can integrity would be necessary for the air to pass into it. In all three LLNL can failure cases, it is believed that the seal of the inner can was not sufficient to prevent a breach of the can environment.

28783 (UCRL-ID–121434) **Transportation environmental safety analysis of the commercial movement of low enriched uranium (LEU) from DOE sites to the Oak Ridge Y-12 Plant.** Brumburgh, G.P. Lawrence Livermore National Lab., CA (United States). 8 Aug 1995. 9p. Sponsored by USDOE, Washington, DC (United States). DOE Contract W-7405-ENG-48. Order Number DE96000843. Source: OSTI; NTIS; INIS; GPO Dep.

This report documents the technical basis for evaluating the environmental impacts of transporting three metric tons (MTU) of Low Enriched Uranium (LEU) by commercial carrier from DOE sites to the Oak Ridge Y-12 Plant located in Tennessee. The RADTRAN 4 computer code and the HIGHWAY 3.1 computer routing program developed by Sandia National Laboratories and Oak Ridge National Laboratory respectively, were the primary tools utilized in this analysis. The information contained within this report is supplemental to the transportation analysis conducted in the Environmental Assessment for the Proposed Interim Storage of Enriched Uranium Above the Maximum Historical Storage Level at the Y-12 Plant Oak Ridge, Tennessee (DOE-EA/0929). The results of this analysis indicate that the radiological consequences imposed under both incident-free and accident conditions are extremely small and readily meet the goals as set forth in SEN-35-91.

28784 (WHC-SA–2781) **International shipment of plutonium by air.** Mercado, J.E.; McGrogan, J.P. Westinghouse Hanford Co., Richland, WA (United States). May 1995. 8p. Sponsored by USDOE, Washington, DC (United States). DOE Contract AC06-87RL10930. (CONF-9506150–7: 2. annual Department of Energy defense programs packaging workshop, San Francisco, CA (United States), 12-15 Jun 1995). Order Number DE95016337. Source: OSTI; NTIS; INIS; GPO Dep.

In support of the United States (US) Government's decision to place excess plutonium oxide at the US Department of Energy's (DOE) Hanford Site under International Atomic Energy Agency (IAEA) safeguards, the Department of State notified the Congress that a plutonium storage vault at the Plutonium Finishing Plant at the Hanford Site would be added to the eligible facilities list. As part of the preparations to transfer the plutonium oxide under IAEA safeguards, samples of the powder were taken from the inventory to be shipped to the IAEA headquarters in Vienna, Austria, for laboratory analysis. The analysis of these samples was of high priority, and the IAEA requested that the material be shipped by aircraft, the most expeditious method.

28785 (WHC-SP–1168) **Packaging design criteria for the Type B Drum.** Edwards, W.S.; Smith, R.J.; Wells, A.H. Westinghouse Hanford Co., Richland, WA (United States). Sep 1995. 26p. Sponsored by USDOE, Washington, DC (United States). DOE Contract AC06-87RL10930. Order Number DE96001632. Source: OSTI; NTIS; INIS; GPO Dep.

The Type B Drum package is a transportation cask capable of shipping a single 55-gal (208 L) drum of transuranic (TRU) waste. The Type B Drum is smaller than existing certified packages, such as the TRUPACT-II cask, but will allow payloads with higher thermal and gas generation rates, thus providing greater operational flexibility. The Type B Drum package has double containment so that plutonium contents and other radioactive material may be transported in Type B quantities. Conceptual designs of unshielded and shielded versions of the Type B Drum were completed in Report on the Conceptual Design of the Unshielded Type B Drum Packaging and Report on the Conceptual Design of the Shielded type B Drum Packaging (WEC 1994a, WEC 1994b), which demonstrated the Type B Drum to be a viable packaging system. A Type B package containment system must withstand the normal conditions of transport and the hypothetical accident conditions, which include a 9-m (30-ft) drop onto an unyielding surface and a 1-m (3-ft) drop onto a 15-cm (6-in.) diameter pin, and a fire and immersion scenarios.

0510 Economic, Industrial, and Business Aspects

Refer also to citation(s) 28825, 28831, 28881

28786 (Y/NA–1801) **Depleted uranium market study. Final report.** Kaplan, S.A. (Kapline Enterprises, Inc., Knoxville, TN (United States)). Oak Ridge National Lab., TN (United States). Aug 1995. 223p. Sponsored by USDOE, Washington, DC (United States). DOE Contract AC05-84OS21400. Order Number DE96000383. Source: OSTI; NTIS (US Sales Only); GPO Dep.

The objective of this study is to identify potential markets for depleted uranium (DU) materials and products that may be developed by 2005. For each potential market, the study identifies the maximum amount of DU that might be used, the probability that the use will develop, and the time period or schedule for the product or market to reach maturity. The report also describes and attempts to quantify benefits from the development of the market and commercialization of a product, such as financial gains in a community due to increase in industrial base (i.e., jobs). A cost threshold for maximum development potential of each DU market or product is also established. This threshold is based on the cost of currently used products in each application. Such a threshold is necessary because the DU material considered is in the form of uranium hexafluoride (UF_6) and current conversion methods of depleted UF_6 are expensive and produces large quantities of waste products. In addition to cost, the study identifies other barriers such as public perception, environmental and health concerns, regulatory restrictions, and engineering constraints.

0520 Waste Management

Refer also to citation(s) 28770, 28771, 28772, 28773, 29010, 29011, 29012, 29029, 29030, 29032, 29033, 29042, 29043, 29044, 29047, 29048, 29049, 29050, 29073, 29075, 29076, 29082, 29083, 29084, 29088, 29092, 29099, 29102, 29105, 29106, 29111, 29113, 29118, 29157, 29159, 29543, 29544, 29545, 29546, 29548, 29550, 29551, 29554, 29555, 29557, 29558, 29559, 29560, 29561, 29562,

29563, 29568, 29827, 29835, 29847, 29855, 29952, 29982, 30052, 30075, 30169, 30222, 30223, 30224, 30281, 30287, 30321, 30331, 30409, 30458, 30459, 30612, 30635, 30668, 30683, 30688, 30689, 30690, 30691, 30692, 30693, 30699, 30711, 30717, 30718, 30729, 30744, 30764, 30767, 30784, 30850, 30851, 31323, 31324

28787 (ANL/ACL–95/3) **Waste minimization through high-pressure microwave digestion of soils for gross α/β analyses.** Yaeger, J.S.; Smith, L.L. Argonne National Lab., IL (United States). Apr 1995. 17p. Sponsored by USDOE, Washington, DC (United States). DOE Contract W-31109-ENG-38. Order Number DE95017580. Source: OSTI; NTIS; INIS; GPO Dep.

As a result of the U.S. Department of Energy's (DOE) environmental restoration and waste management activities, laboratories receive numerous analytical requests for gross α/β analyses. Traditional sample preparation methods for gross α/β analysis of environmental and mixed waste samples require repetitive leaching, which is time consuming and generates large volumes of secondary wastes. An alternative to leaching is microwave digestion. In the past. microwave technology has had limited application in the radiochemical laboratory because of restrictions on sample size resulting from vessel pressure limitations. However, new microwave vessel designs allow for pressures on the order of 11 MPa (1500 psi). A procedure is described in which microwave digestion is used to prepare environmental soil samples for gross α/β analysis. Results indicate that the described procedure meets performance requirements for several soil types and is equivalent to traditional digestion techniques. No statistical differences at the 95% confidence interval exist between the measurement on samples prepared from the hot plate and microwave digestion procedures for those soils tested. Moreover, microwave digestion allows samples to be prepared in a fraction of the time with significantly less acid and with lower potential of cross-contamination. In comparison to the traditional hot plate method, the waste volumes required for the microwave procedure are a factor of 10 lower, while the analyst time for sample processing is at least a factor of three lower.

28788 (ANL/CMT/CP–84846) **Vitrification as a low-level radioactive mixed waste treatment technology at Argonne National Laboratory.** Mazer, J.J.; No, Hyo J. Argonne National Lab., IL (United States). [1995]. 13p. Sponsored by USDOE, Washington, DC (United States). DOE Contract W-31-109-ENG-38. (CONF-950877–14: 3. American Society for Mechanical Engineers biennial mixed waste symposium, Baltimore, MD (United States), 7-11 Aug 1995). Order Number DE95015713. Source: OSTI; NTIS; INIS; GPO Dep.

Argonne National Laboratory-East (ANL-E) is developing plans to use vitrification to treat low-level radioactive mixed wastes (LLMW) generated onsite. The ultimate objective of this project is to install a full-scale vitrification system at ANL-E capable of processing the annual generation and historic stockpiles of selected LLMW streams. This project is currently in the process of identifying a range of processible glass compositions that can be produced from actual mixed wastes and additives, such as boric acid or borax. During the formulation of these glasses, there has been an emphasis on maximizing the waste content in the glass (70 to 90 wt %), reducing the overall final waste volume, and producing a stabilized low-level radioactive waste glass. Crucible glass studies with actual mixed waste streams have produced alkali borosilicate glasses that pass the Toxic Characteristic Leaching Procedure (TCLP) test. These same glass compositions, spiked with toxic metals well above the expected levels in actual wastes, also pass the TCLP test. These results provide compelling evidence that the vitrification system and the glass waste form will be robust enough to accommodate expected variations in the LLMW streams from ANL-E. Approximately 40 crucible melts will be studied to establish a compositional envelope for vitrifying ANL-E mixed wastes. Also being determined is the identity of volatilized metals or off-gases that will be generated.

28789 (ANL/EA/CP–86245) **Issues related to estimating potential radiological doses from treatment, storage, and disposal facilities handling waste containing trace amounts of radioactive material.** Stevens, L.E. (USDOE, Washington, DC (United States)); Nimmagadda, M.; LePoire, D.; Chen, S.Y.; Ma, C.W.; Wheeler, T.; Owens, K.W. Argonne National Lab., IL (United States). [1995]. 10p. Sponsored by USDOE, Washington, DC (United States). DOE Contract W-31109-ENG-38. (CONF-950868–12: Environmental remediation conference: committed to results, Denver, CO (United States), 13-18 Aug 1995). Order Number DE95015636. Source: OSTI; NTIS; INIS; GPO Dep.

A simplified calculational model has been developed to permit a rapid, yet realistic, estimate of potential radiological doses to on-site workers and the off-site public from waste-handling operations at a treatment, storage, and disposal (TSD) facility. The waste-handling operations include transport, handling, storage, incineration, and landfilling of waste containing trace amounts of radioactive materials. The main objective of the model is to provide a radiological assessment methodology that can be used in a waste clearance strategy that addresses US Department of Energy mixed-waste moratorium issues. The model was developed on the basis of previous detailed studies of eight TSD facilities and incorporates the essential features of such a facility. The model provides a simplified physical concept of the potential human exposure associated with the radioactive contents of the chemical wastes. Issues pertaining to the development of the model, as well as application and future use, are discussed. Specifically, these issues include physical model approximations, isotope selection, waste-handling operations, and selection of input parameters. Also, pathway and isotope selection criteria are discussed relative to the previous TSD sites studied. This model is being considered for additional development as a waste clearance strategy tool.

28790 (ANL/EAD/TM–17-Draft) **High-level waste inventory, characteristics, generation, and facility assessment for treatment, storage, and disposal alternatives considered in the U.S. Department of Energy Environmental Management Programmatic Environmental Impact Statement.** Folga, S.M. (Argonne National Lab., IL (United States). Environmental Assessment Div.); Conzelmann, G.; Gillette, J.L.; Kier, P.H.; Poch, L.A. Argonne National Lab., IL (United States). Apr 1995. 160p. Sponsored by USDOE, Washington, DC (United States). DOE Contract W-31109-ENG-38. Order Number DE95017834. Source: OSTI; NTIS; INIS; GPO Dep.

This report provides data and information needed to support the risk and impact assessments of high-level waste (HLW) management alternatives in the US Department of Energy Waste Management (WM) Programmatic Environmental Impact Statement (PEIS). Available data on the physical form, chemical and isotopic composition, storage locations, and other waste characteristics of interest are presented. High-level waste management follows six implementation phases: current storage, retrieval, pretreatment, treatment, interim canister storage, and geologic repository disposal; pretreatment, treatment, and repository disposal are outside the scope of the WM PEIS. Brief descriptions of current and planned HLW management facilities are provided, including information on the type of waste managed in the facility, costs, product form, resource requirements, emissions, and current and future status. Data sources and technical and regulatory assumptions are identified. The range of HLW management alternatives (including decentralized, regionalized, and centralized approaches) is described. The required waste management facilities include expanded interim storage facilities under the various alternatives. Resource requirements for construction (e.g., land and materials) and operation (e.g., energy and process chemicals), work force, costs, effluents, design capacities, and emissions are presented for each alternative.

28791 (ANL/EAD/TM–18-Draft) **Risk assessment for the on-site transportation of radioactive wastes for the U.S. Department of Energy Waste Management programmatic environmental impact statement.** Biwer, B.M.; Monette, F.A.; Chen, S.Y. Argonne National Lab., IL (United States). Apr 1995. 65p. Sponsored by USDOE, Washington, DC (United States). DOE Contract W-31109-ENG-38. Order Number DE95017833. Source: OSTI; NTIS; INIS; GPO Dep.

This report documents the risk assessment performed for the on-site transportation of radioactive wastes in the U.S. Department of Energy (DOE) Waste Management (WM) Programmatic Environmental Impact Statement (PEIS). Risks for the routine shipment of

wastes and the impacts from potential accidental releases are analyzed for operations at the Hanford Site (Hanford) near Richland, Washington. Like other large DOE sites, Hanford conducts waste management operations for all wastes types; consequently, the impacts calculated for Hanford are expected to be greater than those for smaller sites. The risk assessment conducted for on-site transportation is intended to provide an estimate of the magnitude of the potential risk for comparison with off-site transportation risks assessed for the WM PEIS.

28792 (ANL/EAD/TM–20-Draft) **Low-level waste inventory, characteristics, generation, and facility assessment for treatment, storage, and disposal alternatives considered in the U.S. Department of Energy Waste Management Programmatic Environmental Impact Statement.** Goyette, M.L. (Argonne National Lab., IL (United States). Environmental Assessment Div.). Argonne National Lab., IL (United States). Apr 1995. 250p. Sponsored by USDOE, Washington, DC (United States). DOE Contract W-31109-ENG-38. Order Number DE95017832. Source: OSTI; NTIS; INIS; GPO Dep.

This report provides technical support information for use in analyzing environmental impacts associated with US Department of Energy (DOE) low-level radioactive waste (LLW) management alternatives in the Waste Management (WM) Programmatic Environmental Impact Statement (PEIS). Waste loads treated and disposed of for each of the LLW alternatives considered in the DOE WM PEIS are presented. Waste loads are presented for DOE Waste Management (WM) wastes, which are generated from routine operations. Radioactivity concentrations and waste quantities for treatment and disposal under the different LLW alternatives are described for WM waste. Waste loads treated and disposed of for the LLW alternatives and subalternatives, or cases, addressed in the WM PEIS but not included in this report are presented in the Addendum.

28793 (ANL/EAD/TM–22-Draft) **Transuranic waste inventory, characteristics, generation, and facility assessment for treatment, storage, and disposal alternatives considered in the U.S. Department of Energy waste management programmatic environmental impact statement.** Hong, K. (and others); Kotek, T.; Koebnick, B. Argonne National Lab., IL (United States). Environmental Assessment Div. Apr 1995. 105p. Sponsored by USDOE, Washington, DC (United States). DOE Contract W-31109-ENG-38. Order Number DE95017826. Source: OSTI; NTIS; INIS; GPO Dep.

Transuranic waste (TRUW) loads and potential contaminant releases at and en route to treatment, storage, and disposal sites in the U.S. Department of Energy (DOE) complex are important considerations in DOE's Waste Management Programmatic Environmental Impact Statement (WM PEIS). Waste loads are determined in part by the level of treatment the waste has undergone and the complexwide configuration of origination, treatment, storage, and disposal sites selected for TRUW management. Other elements that impact waste loads are treatment volumes, waste characteristics, and the unit operation parameters of the treatment technologies. Treatment levels and site configurations have been combined into 10 TRUW management alternatives for study in the WM PEIS. This supplemental report to the WM PEIS gives the projected waste loads and contaminant release profiles for DOE treatment sites under each of the 10 TRUW management alternatives. It gives TRUW characteristics and inventories for current DOE generation and storage sites, describes the treatment technologies for three levels of TRUW treatment, and presents the representative unit operation parameters of the treatment technologies. The data presented are primary inputs to developing the costs, health risks, and socioeconomic and environmental impacts of treating, packaging, and shipping TRUW for disposal.

28794 (ANL/EAD/TM–25-Draft) **Hazardous waste inventory, characteristics, generation, and facility assessment for treatment, storage, and disposal alternatives considered in the U.S. Department of Energy Waste Management Programmatic Environmental Impact Statement.** Lazaro, M.A. (Argonne National Lab., IL (United States). Environmental Assessment Div.); Antonopoulos, A.A.; Policastro, A.J.; Esposito, M.P. Argonne National Lab., IL (United States). Apr 1995. 98p. Sponsored by USDOE, Washington, DC (United States). DOE Contract W-31109-ENG-38. Order Number DE95017830. Source: OSTI; NTIS; INIS; GPO Dep.

This report focuses on the generation of hazardous waste (HW) and the treatment, storage, and disposal (TSD) of HW being generated by routine US Department of Energy (DOE) facility operations. The wastes to be considered are managed by the DOE Waste Management (WM) Division (WM HW). The waste streams are to be sent to WM operations throughout the DOE complex under four management alternatives: No Action, Decentralization, Regionalized 1, and Regionalized 2. On-site and off-site capabilities for TSD are examined for each alternative. This report (1) summarizes the HW inventories and generated amounts resulting from WM activities, focusing on the largest DOE HW generators; (2) presents estimates of the annual amounts shipped off-site, as well as the amounts treated by various treatment technology groups; (3) describes the existing and planned treatment and storage capabilities of the largest HW-generating DOE installations, as well as the use of commercial TSD facilities by DOE sites; (4) presents applicable technologies (destruction of organics, deactivation/neutralization of waste, removal/recovery of organics, and aqueous liquid treatment); and (5) describes the four alternatives for consideration for future HW management, and for each alternative provides the HW loads and the approach used to estimate the source term for routine TSD operations. In addition, potential air emissions, liquid effluents, and solid residuals associated with each alternative are presented. Furthermore, this report is supplemented with an addendum that includes detailed information related to HW inventory, characteristics, generation, and facility assessment for the TSD alternatives. The addendum also presents source terms, emission rates, and throughput totals by alternative and treatment installation.

28795 (ANL/EAD/TM–28-Draft) **Risk assessment for the transportation of hazardous waste and hazardous waste components of low-level mixed waste and transuranic waste for the U.S. Department of Energy waste management programmatic environmental impact statement.** Lazaro, M.A. (and others); Policastro, A.J.; Hartmann, H.M. Argonne National Lab., IL (United States). Apr 1995. 93p. Sponsored by USDOE, Washington, DC (United States). DOE Contract W-31109-ENG-38. Order Number DE95017829. Source: OSTI; NTIS; INIS; GPO Dep.

This report, a supplement to Appendix E (Transportation Risk) of the U.S. Department of Energy Waste Management Programmatic Environmental Impact Statement (WM PEIS), provides additional information supporting the accident data for chemical risk assessment and health risk methodology described in that appendix (Part II), as well as providing the uncertainty analysis and on-site risk calculations. This report focuses on hazardous material truck accident rates, release probabilities, and release quantities; provides the toxicological values derived for each hazardous chemical assessed in the WM PEIS and further details on the derivation of health criteria; describes the method used in the transportation risk assessments to address potential additivity of health effects from simultaneous exposure to several chemicals and the method used to address transportation risks for maximally exposed individuals; presents an expanded discussion of the uncertainty associated with transportation risk calculations; and includes the results of the on-site transportation risk analysis. In addition, two addenda are provided to detail the risk assessments conducted for the hazardous components of low-level mixed waste (Addendum I) and transuranic waste (Addendum II).

28796 (ANL/EAD/TM–29-Draft-Vol.1) **Analysis of accident sequences and source terms at waste treatment and storage facilities for waste generated by U.S. Department of Energy Waste Management Operations, Volume 1: Sections 1-9.** Mueller, C. (and others); Nabelssi, B.; Roglans-Ribas, J. Argonne National Lab., IL (United States). Apr 1995. 144p. Sponsored by USDOE, Washington, DC (United States). DOE Contract W-31109-ENG-38. Order Number DE95017805. Source: OSTI; NTIS; INIS; GPO Dep.

This report documents the methodology, computational framework, and results of facility accident analyses performed for the U.S. Department of Energy (DOE) Waste Management Programmatic Environmental Impact Statement (WM PEIS). The accident

sequences potentially important to human health risk are specified, their frequencies are assessed, and the resultant radiological and chemical source terms are evaluated. A personal computer-based computational framework and database have been developed that provide these results as input to the WM PEIS for calculation of human health risk impacts. The methodology is in compliance with the most recent guidance from DOE. It considers the spectrum of accident sequences that could occur in activities covered by the WM PEIS and uses a graded approach emphasizing the risk-dominant scenarios to facilitate discrimination among the various WM PEIS alternatives. Although it allows reasonable estimates of the risk impacts associated with each alternative, the main goal of the accident analysis methodology is to allow reliable estimates of the relative risks among the alternatives. The WM PEIS addresses management of five waste streams in the DOE complex: low-level waste (LLW), hazardous waste (HW), high-level waste (HLW), low-level mixed waste (LLMW), and transuranic waste (TRUW). Currently projected waste generation rates, storage inventories, and treatment process throughputs have been calculated for each of the waste streams. This report summarizes the accident analyses and aggregates the key results for each of the waste streams. Source terms are estimated and results are presented for each of the major DOE sites and facilities by WM PEIS alternative for each waste stream. The appendices identify the potential atmospheric release of each toxic chemical or radionuclide for each accident scenario studied. They also provide discussion of specific accident analysis data and guidance used or consulted in this report.

28797 (ANL/EAD/TM–29-Draft-Vol.3) **Analysis of accident sequences and source terms at waste treatment and storage facilities for waste generated by U.S. Department of Energy Waste Management Operations, Volume 3: Appendixes C-H.** Mueller, C. (and others); Nabelssi, B.; Roglans-Ribas, J. Argonne National Lab., IL (United States). Apr 1995. 150p. Sponsored by USDOE, Washington, DC (United States). DOE Contract W-31109-ENG-38. Order Number DE95017804. Source: OSTI; NTIS; INIS; GPO Dep.

This report contains the Appendices for the Analysis of Accident Sequences and Source Terms at Waste Treatment and Storage Facilities for Waste Generated by the U.S. Department of Energy Waste Management Operations. The main report documents the methodology, computational framework, and results of facility accident analyses performed as a part of the U.S. Department of Energy (DOE) Waste Management Programmatic Environmental Impact Statement (WM PEIS). The accident sequences potentially important to human health risk are specified, their frequencies are assessed, and the resultant radiological and chemical source terms are evaluated. A personal computer-based computational framework and database have been developed that provide these results as input to the WM PEIS for calculation of human health risk impacts. This report summarizes the accident analyses and aggregates the key results for each of the waste streams. Source terms are estimated and results are presented for each of the major DOE sites and facilities by WM PEIS alternative for each waste stream. The appendices identify the potential atmospheric release of each toxic chemical or radionuclide for each accident scenario studied. They also provide discussion of specific accident analysis data and guidance used or consulted in this report.

28798 (ANL/EAD/TM–30-Draft) **Waste-Mgmt: A computer model for calculation of waste loads, profiles, and emissions.** Kotek, T.J.; Avci, H.I.; Koebnick, B.L. Argonne National Lab., IL (United States). Apr 1995. 37p. Sponsored by USDOE, Washington, DC (United States). DOE Contract W-31109-ENG-38. Order Number DE95017800. Source: OSTI; NTIS; INIS; GPO Dep.

WASTE-MGMT is a computational model that provides waste loads, profiles, and emissions for the U.S. Department of Energy's Waste Management Programmatic Environmental Impact Statement (WM PEIS). The model was developed to account for the considerable variety of waste types and processing alternatives evaluated by the WM PEIS. The model is table-driven, with three types of fundamental waste management data defining the input: (1) waste inventories and characteristics; (2) treatment, storage and disposal facility characteristics; and (3) alternative definition. The primary output of the model consists of tables of waste loads and contaminant profiles at facilities, as well as contaminant air releases for each treatment and storage facility at each site for each waste stream. The model is implemented in Microsoft® FoxPro® for MS-DOS® version 2.5 and requires a microcomputer with at least a 386 processor and a minimum 6 MBytes of memory and 10 MBytes of disk space for temporary storage.

28799 (ANL/EAD/TM–32-Draft) **Information related to low-level mixed waste inventory, characteristics, generation, and facility assessment for treatment, storage, and disposal alternatives considered in the U.S. Department of Energy Waste Management programmatic environmental impact statement.** Wilkins, B.D.; Dolak, D.A.; Wang, Y.Y.; Meshkov, N.K. Argonne National Lab., IL (United States). Apr 1995. 200p. Sponsored by USDOE, Washington, DC (United States). DOE Contract W-31109-ENG-38. Order Number DE95017802. Source: OSTI; NTIS; INIS; GPO Dep.

This report was prepared to support the analysis of risks and costs associated with the proposed treatment of low-level mixed waste (LLMW) under management of the U.S. Department of Energy (DOE). The various waste management alternatives for treatment of LLMW have been defined in the DOE's Office of Waste Management Programmatic Environmental Impact Statement. This technical memorandum estimates the waste material throughput expected at each proposed LLMW treatment facility and analyzes potential radiological and chemical releases at each DOE site resulting from treatment of these wastes. Models have been developed to generate site-dependent radiological profiles and waste-stream-dependent chemical profiles for these wastes. Current site-dependent inventories and estimates for future generation of LLMW have been obtained from DOE's 1994 Mixed Waste Inventory Report (MWIR-2). Using treatment procedures developed by the Mixed Waste Treatment Project, the MWIR-2 database was analyzed to provide waste throughput and emission estimates for each of the different waste types assessed in this report. Uncertainties in the estimates at each site are discussed for waste material throughputs and radiological and chemical releases.

28800 (ANL/EAD/TM–35-Draft) **Supplemental information related to risk assessment for the off-site transportation of low-level mixed waste for the U.S. Department of Energy Waste Management programmatic environmental impact statement.** Monette, F.A. (and others); Biwer, B.M.; LePoire, D.J. Argonne National Lab., IL (United States). Apr 1995. 382p. Sponsored by USDOE, Washington, DC (United States). DOE Contract W-31109-ENG-38. Order Number DE95017801. Source: OSTI; NTIS; INIS; GPO Dep.

This report provides supplemental information to support the human health risk assessment conducted for the transportation of low-level mixed waste (LLMW) in support of the US Department of Energy Waste Management Programmatic Environmental Impact Statement (WM PEIS). The assessment considers both the radioactive and chemical hazards associated with LLMW transportation. Detailed descriptions of the transportation health risk assessment methods and results of the assessment are presented in Appendix E of the WM PEIS. This report presents additional information that is not included in Appendix E but is necessary to conduct the transportation risk assessment for Waste Management (WM) LLMW. Included are definitions of the LLMW alternatives considered in the WM PEIS; data related to the inventory and to the physical, chemical, and radiological characteristics of WM LLMW; an overview of the risk assessment methods; and detailed results of the assessment for each WM LLMW case considered.

28801 (ANL/RE/CP–85598) **Structural and seismic analyses of waste facility reinforced concrete storage vaults.** Wang, C.Y. Argonne National Lab., IL (United States). [1995]. 22p. Sponsored by USDOE, Washington, DC (United States). DOE Contract W-31-109-ENG-38. (CONF-950740–86: Joint ASME/JSME pressure vessels and piping conference, Honolulu, HI (United States), 23-27 Jul 1995). Order Number DE95014091. Source: OSTI; NTIS; INIS; GPO Dep.

Facility 317 of Argonne National Laboratory consists of several reinforced concrete waste storage vaults designed and constructed in the late 1940's through the early 1960's. In this paper, structural

analyses of these concrete vaults subjected to various natural hazards are described, emphasizing the northwest shallow vault. The natural phenomenon hazards considered include both earthquakes and tornados. Because these vaults are deeply embedded in the soil, the SASSI (System Analysis of Soil-Structure Interaction) code was utilized for the seismic calculations. The ultimate strength method was used to analyze the reinforced concrete structures. In all studies, moment and shear strengths at critical locations of the storage vaults were evaluated. Results of the structural analyses show that almost all the waste storage vaults meet the code requirements according to ACI 349–85. These vaults also satisfy the performance goal such that confinement of hazardous materials is maintained and functioning of the facility is not interrupted.

28802 (BNL–52478) **Polyethylene encapsulation full-scale technology demonstration. Final report.** Kalb, P.D.; Lageraaen, P.R. Brookhaven National Lab., Upton, NY (United States). Oct 1994. 45p. Sponsored by USDOE, Washington, DC (United States). DOE Contract AC02-76CH00016. Order Number DE96001638. Source: OSTI; NTIS; INIS; GPO Dep.

A full-scale integrated technology demonstration of a polyethylene encapsulation process, sponsored by the US Department of Energy (DOE) Office of Technology Development (OTD), was conducted at the Environmental & Waste Technology Center at Brookhaven National Laboratory (BNL.) in September 1994. As part of the Polymer Solidification National Effort, polyethylene encapsulation has been developed and tested at BNL as an alternative solidification technology for improved, cost-effective treatment of low-level radioactive (LLW), hazardous and mixed wastes. A fully equipped production-scale system, capable of processing 900 kg/hr (2000 lb/hr), has been installed at BNL. The demonstration covered all facets of the integrated processing system including pre-treatment of aqueous wastes, precise feed metering, extrusion processing, on-line quality control monitoring, and process control.

28803 (BNL–61646) **Aging mechanisms for steel components of high-level waste storage tanks.** Weeks, J.; Bandyopadhyay, K.; Bush, S.; Kassir, M.; Mather, B.; Shewmon, P.; Streicher, M.; Thompson, B.; van Rooyen, D. Brookhaven National Lab., Upton, NY (United States). [1995]. 5p. Sponsored by USDOE, Washington, DC (United States). DOE Contract AC02-76CH00016. (CONF-950740–48: Joint ASME/JSME pressure vessels and piping conference, Honolulu, HI (United States), 23-27 Jul 1995). Order Number DE95011775. Source: OSTI; NTIS; INIS; GPO Dep.

High level storage tanks in service at the present time were fabricated from either carbon steel or low-carbon stainless steel, in each case surrounded by a concrete vault. A variety of potential degradation mechanisms may affect these steel tanks, including corrosion, stress-corrosion cracking, fatigue, radiation, erosion, and hydrogen embrittlement. Historically, some of the non-stress-relieved carbon steel tanks have leaked; in the only failure analysis performed to date, stress corrosion cracking in the heat-affected zone (HAZ) of the weld was identified as the cause. Potentially significant aging mechanisms include general corrosion, pitting and/or crevice corrosion stress-corrosion cracking, microbiologically-induced corrosion, concentration cell attack, and corrosion of external tank surfaces by in-leakage of ground water. Aging mechanisms which are deemed non-significant include thermal and radiation embrittlement, creep and stress relaxation, fatigue, erosion and erosion/corrosion wear, and hydrogen embrittlement. Justification for the potential significance or non-significance for each mechanism is provided, based on the current understanding of these processes and the environments to which the tanks are exposed.

28804 (BNL–62204) **Polyethylene encapsulation of molten salt oxidation mixed low-level radioactive salt residues.** Lageraaen, P.R. (Brookhaven National Lab., Upton, NY (United States)); Kalb, P.D.; Grimmett, D.L.; Gay, R.L.; Newman, C.D. Brookhaven National Lab., Upton, NY (United States). [1995]. 8p. Sponsored by USDOE, Washington, DC (United States). DOE Contract AC02-76CH00016. (CONF-950877–19: 3. American Society for Mechanical Engineers biennial mixed waste symposium, Baltimore, MD (United States), 7-11 Aug 1995). Order Number DE96000415. Source: OSTI; NTIS; INIS; GPO Dep.

A limited scope treatability study was conducted for polyethylene encapsulation of salt residues generated by a Molten Salt Oxidation (MSO) technology demonstration at the Energy Technology Engineering Center (ETEC), operated by Rockwell International for the US Department of Energy (DOE). During 1992 and 1993, ETEC performed a demonstration with a prototype MSO unit and treated approximately 50 gallons of mixed waste comprised of radioactively contaminated oils produced by hot cell operations. A sample of the mixed waste contaminated spent salt was used during the BNL polyethylene encapsulation treatability study. A nominal waste loading of 50 wt % was successfully processed and waste form test specimens were made for Toxicity Characteristic Leaching Procedure (TCLP) testing. The encapsulated product was compared with base-line TCLP results for total chromium and was found to be well within allowable EPA guidelines.

28805 (CONF-941102–46) **Determination of operating limits for radionuclides for a proposed landfill at Paducah Gaseous Diffusion Plant.** Wang, J.C.; Lee, D.W.; Ketelle, R.H.; Lee, R.R.; Kocher, D.C. Oak Ridge National Lab., TN (United States). 24 May 1994. 25p. Sponsored by USDOE, Washington, DC (United States). DOE Contract AC05-84OR21400. From Winter meeting of the American Nuclear Society; Washington, DC (United States); 13-18 Nov 1994. Order Number DE95014032. Source: OSTI; NTIS; INIS; GPO Dep.

The operating limits for radionuclides in sanitary and industrial wastes were determined for a proposed landfill at the Paducah Gaseous Diffusion Plant (PGDP), Kentucky. These limits, which may be very small but nonzero, are not mandated by law or regulation but are needed for rational operation. The approach was based on analyses of the potential contamination of groundwater at the plant boundary and the potential exposure to radioactivity of an intruder at the landfill after closure. The groundwater analysis includes (1) a source model describing the disposal of waste and the release of radionuclides from waste to the groundwater, (2) site-specific groundwater flow and contaminant transport calculations, and (3) calculations of operating limits from the dose limit and conversion factors. The intruder analysis includes pathways through ingestion of contaminated vegetables and soil, external exposure to contaminated soil, and inhalation of suspended activity from contaminated soil particles. In both analyses, a limit on annual effective dose equivalent of 4 mrem (0.04 mSv) was adopted. The intended application of the results is to refine the radiological monitoring standards employed by the PGDP Health Physics personnel to determine what constitutes radioactive wastes, with concurrence of the Commonwealth of Kentucky.

28806 (CONF-9507150–2) **On-site laboratory support of Oak Ridge National Laboratory environmental restoration field activities.** Burn, J.L.E. (Bechtel Environmental, Inc., Oak Ridge, Tennessee (United States)). Oak Ridge National Lab., TN (United States). Jul 1995. 10p. Sponsored by USDOE, Washington, DC (United States). DOE Contract AC05-84OR21400. From 11. annual waste testing and quality assurance symposium; Washington, DC (United States); 23-28 Jul 1995. Order Number DE95016346. Source: OSTI; NTIS; INIS; GPO Dep.

A remedial investigation/feasibility study has been undertaken at Oak Ridge National Laboratory (ORNL). Bechtel National, Inc. and partners CH2M Hill, Ogden Environmental and Energy Services, and PEER Consultants are contracted to Lockheed Martin Energy Systems, performing this work for ORNL's Environmental Restoration (ER) Program. An on-site Close Support Laboratory (CSL) established at the ER Field Operations Facility has evolved into a laboratory where quality analytical screening results can be provided rapidly (e.g., within 24 hours of sampling). CSL capabilities include three basic areas: radiochemistry, chromatography, and wet chemistry. Radiochemical analyses include gamma spectroscopy, tritium and carbon-14 screens using liquid scintillation analysis, and gross alpha and beta counting. Cerenkov counting and crown-ether-based separation are the two rapid methods used for radiostrontium determination in water samples. By extending count times where appropriate, method detection limits can match those achieved by off-site contract laboratories. Volatile organic compounds are detected by means of gas chromatography using either headspace or purge and trap sample introduction (based on

EPA 601/602). Ionic content of water samples is determined using ion chromatography and alkalinity measurement. Ion chromatography is used to quantify both anions (based on EPA 300) and cations. Wet chemistry procedures performed at the CSL include alkalinity, pH (water and soil), soil resistivity, and dissolved/suspended solids. Besides environmental samples, the CSL routinely screens health and safety and waste management samples. The cost savings of the CSL are both direct and indirect.

28807 (DOE/EIS–0200-D-Summ.) **Draft Waste Management Programmatic Environmental Impact Statement for managing treatment, storage, and disposal of radioactive and hazardous waste. Summary.** USDOE Office of Environmental Restoration and Waste Management, Washington, DC (United States). Aug 1995. 70p. Sponsored by USDOE, Washington, DC (United States). Order Number DE95017564. Source: OSTI; NTIS; INIS; GPO Dep.

This is a summary of the Draft klaste Management Programmatic Environmental Impact Statement, which has been prepared in accordance with the National Environmental Policy Act to evaluate management and siting alternatives for the treatment, storage and/or disposal of five types of radioactive and/or hazardous wastes. These waste types are: low-level radioactive waste; low-level mixed (with hazardous components) waste; transuranic waste; high-level radioactive waste; an hazardous waste. The alternatives were evaluated for waste stored, buried or to be generated from future operations over the next 20 years at 54 sites. For each waste type, the analyses contained in this document examined the potential health and environmental impacts of integrated waste management program alternatives involving multiple sites, as well as the potential cumulative impacts.

28808 (DOE/ID–10515) **Vitrification melter study.** Jones, J.A. USDOE Idaho Operations Office, Idaho Falls, ID (United States). Apr 1995. 25p. Sponsored by USDOE, Washington, DC (United States). DOE Contract AC07-76ID01570. Order Number DE96001155. Source: OSTI; NTIS; INIS; GPO Dep.

This report presents the results of a study performed to identify the most promising vitrification melter technologies that the Department of Energy (EM-50) might pursue with available funding. The primary focus was on plasma arc systems and graphite arc melters. The study was also intended to assist EM-50 in evaluating competing technologies, formulating effective technology strategy, developing focused technology development projects, and directing the work of contractors involved in vitrification melter development.

28809 (DOE/ID–22118) **Hydrological and meteorological data for an unsaturated-zone study area near the Radioactive Waste Management Complex, Idaho National Engineering Laboratory, Idaho, 1988 and 1989.** Pittman, J.R. Geological Survey, Idaho Falls, ID (United States). Jan 1995. 120p. Sponsored by Geological Survey, Reston, VA (United States). (USGS-OFR–95-112). Order Number DE96001161. Source: OSTI; NTIS; U.S Geological Survey, Earth Science Information Center, Open-File Reports Section, Box 25286, Mail Stop 517, Federal Center, Denver, CO 80225; GPO Dep.

Trenches and pits at the Radioactive Waste Management Complex (RWMC) at the Idaho National Engineering Laboratory have been used for burial of radioactive waste since 1952. In 1985, the US Geological Survey, in cooperation with the US Department of Energy, began a multi-phase study of the geohydrology of the RWMC to provide a basis for estimating the extent of and the potential for migration of radionuclides in the unsaturated zone beneath the waste trenches and pits. This phase of the study is being conducted to provide hydrological and meteorological data for an area adjacent to the northern boundary of the RWMC.

28810 (DOE/LLW–128) **National Low-Level Waste Management Program Radionuclide Report Series: Volume 12, Cobalt-60.** Adams, J.P. Lockheed Idaho Technologies Co., Idaho Falls, ID (United States). Jun 1995. 40p. Sponsored by USDOE, Washington, DC (United States). DOE Contract AC07-94ID13223. Order Number DE95017655. Source: OSTI; NTIS; INIS; GPO Dep.

This report outlines the basic radiological and chemical characteristics of cobalt-60 (^{60}Co) and examines how these characteristics affect the behavior of ^{60}Co in various environmental media, such as soils, groundwater, plants, animals, the atmosphere, and the human body. Discussions also include methods of ^{60}Co production, waste types, and waste forms that contain ^{60}Co. All cobalt atoms contain 27 protons (Z = 27) and various numbers of neutrons (typically N = 27 to 37 neutrons) within the atom's nucleus. There is only one stable isotope of cobalt, namely ^{59}Co. All other cobalt isotopes, including ^{60}Co, are radioactive. The radioactive isotopes of cobalt have half-lives ranging from less than a second (^{54}Co-0.19 s) to 5.2 years (^{60}Co). The radioactive isotopes of cobalt are not a normal constituent of the natural environment and are generated as a result of human activities. The primary source of ^{60}Co in the environment has been low-level radioactive waste material generated as a result of neutron activation of stable ^{59}Co that is present in the structural components of nuclear reactor vessels. This isotope is also intentionally produced, usually in reactors but also to some degree in accelerators for industrial and medical uses, such as for radiation sources for cancer treatment and nondestructive testing of metals and welds. ^{60}Co may enter the environment as a result of the activities associated with nuclear reactor operations and decommissioning and when industrial and medical sources are being used, manufactured, or disposed.

28811 (DOE/LLW–129-Vol.13) **National Low-Level Waste Management Program radionuclide report series. Volume 13, Curium-242.** Adams, J.P. Lockheed Idaho Technologies Co., Idaho Falls, ID (United States). Aug 1995. 40p. Sponsored by USDOE, Washington, DC (United States). DOE Contract AC07-94ID13223. Order Number DE96001323. Source: OSTI; NTIS; INIS; GPO Dep.

This report, Volume 13 of the National Low-Level Waste Management Program Radionuclide Report Series, discusses the radiological and chemical characteristics of curium-242 (^{242}Cm). This report also includes discussions about waste types and forms in which ^{242}Cm can be found and ^{242}Cm behavior in the environment and in the human body.

28812 (DOE/LLW–186) **Social and institutional evaluation report for Greater-Than-Class C Low-Level Radioactive Waste Disposal.** Anderson, T.L. (Dames and Moore, Denver, CO (United States)); Lewis, B.E.; Turner, K.H.; Rozelle, M.A. EG and G Idaho, Inc., Idaho Falls, ID (United States); Dames and Moore, Denver, CO (United States). Oct 1993. 40p. Sponsored by USDOE, Washington, DC (United States). DOE Contract AC07-76ID01570. Order Number DE95017654. Source: OSTI; NTIS; INIS; GPO Dep.

This report identifies and characterizes social and institutional issues that would be relevant to the siting, licensing, construction, closure, and postclosure of a Greater-Than-Class-C low-level radioactive waste (GTCC LLW) disposal facility. A historical perspective of high-level radioactive waste (HLW) and LLW disposal programs is provided as an overview of radioactive waste disposal and to support the recommendations and conclusions in the report. A characterization of each issue is provided to establish the basis for further evaluations. Where applicable, the regulatory requirements of 10 CFR 60 and 61 are incorporated in the issue characterizations. The issues are used to compare surface, intermediate depth, and deep geologic disposal alternatives. The evaluation establishes that social and institutional issues do not significantly discriminate among the disposal alternatives. Recommendations are provided for methods by which the issues could be considered throughout the lifecycle of a GTCC LLW disposal program.

28813 (DOE/LLW–187) **Introduction to radiological performance assessment.** Moss, G. Lockheed Idaho Technologies Co., Idaho Falls, ID (United States). Feb 1995. 28p. Sponsored by USDOE, Washington, DC (United States). DOE Contract AC07-94ID13223. Order Number DE96001326. Source: OSTI; NTIS; INIS; GPO Dep.

A radiological performance assessment is conducted to provide reasonable assurance that performance objectives for low-level radioactive waste (LLW) disposal will be met. Beginning in the early stages of development, a radiological performance assessment continues through the operational phase, and is instrumental in the postclosure of the facility. Fundamental differences exist in the regulation of commercial and defense LLW, but the radiological performance assessment process is essentially the same for both. The purpose of this document is to describe that process in a concise

and straightforward manner. This document focuses on radiological performance assessment as it pertains to commercial LLW disposal, but is applicable to US Department of Energy sites as well. Included are discussions on performance objectives, site characterization, and how a performance assessment is conducted. A case study is used to illustrate how the process works as a whole. A bibliography is provided to assist in locating additional information.

28814 (DOE/LLW–189) **Developing operating procedures for a low-level radioactive waste disposal facility.** Sutherland, A.A. (Rogers and Associates Engineering Corp., Salt Lake City, UT (United States)); Miner, G.L.; Grahn, K.F.; Pollard, C.G. EG and G Idaho, Inc., Idaho Falls, ID (United States); Rogers and Associates Engineering Corp., Salt Lake City, UT (United States). Oct 1993. 250p. Sponsored by USDOE, Washington, DC (United States). DOE Contract AC07-76ID01570. (RAE–9304/1-1). Order Number DE96001576. Source: OSTI; NTIS; INIS; GPO Dep.

This document is intended to assist persons who are developing operating and emergency procedures for a low-level radioactive waste disposal facility. It provides 25 procedures that are considered to be relatively independent of the characteristics of a disposal facility site, the facility design, and operations at the facility. These generic procedures should form a good starting point for final procedures on their subjects for the disposal facility. In addition, this document provides 55 annotated outlines of other procedures that are common to disposal facilities. The annotated outlines are meant as checklists to assist the developer of new procedures.

28815 (DOE/LLW–199) **Comparative approaches to siting low-level radioactive waste disposal facilities.** Newberry, W.F. EG and G Idaho, Inc., Idaho Falls, ID (United States). Jul 1994. 119p. Sponsored by USDOE, Washington, DC (United States). DOE Contract AC07-76ID01570. Order Number DE96001577. Source: OSTI; NTIS; INIS; GPO Dep.

This report describes activities in nine States to select site locations for new disposal facilities for low-level radioactive waste. These nine States have completed processes leading to identification of specific site locations for onsite investigations. For each State, the status, legal and regulatory framework, site criteria, and site selection process are described. In most cases, States and compact regions decided to assign responsibility for site selection to agencies of government and to use top-down mapping methods for site selection. The report discusses quantitative and qualitative techniques used in applying top-down screenings, various approaches for delineating units of land for comparison, issues involved in excluding land from further consideration, and different positions taken by the siting organizations in considering public acceptance, land use, and land availability as factors in site selection.

28816 (DOE/LLW–208) **National Institutes of Health: Mixed waste stream analysis.** Kirner, N.P.; Faison, G.P.; Johnson, D.R. EG and G Idaho, Inc., Idaho Falls, ID (United States). Aug 1994. 60p. Sponsored by USDOE, Washington, DC (United States). DOE Contract AC07-76ID01570. Order Number DE95017656. Source: OSTI; NTIS; INIS; GPO Dep.

The Low-Level Radioactive Waste Policy Amendments Act of 1985 requires that the US Department of Energy (DOE) provide technical assistance to host States, compact regions, and unaffiliated States to fulfill their responsibilities under the Act. The National Low-Level Waste Management Program (NLLWMP) operated for DOE by EG&G Idaho, Inc. provides technical assistance in the development of new commercial low-level radioactive waste disposal capacity. The NLLWMP has been requested by the Appalachian Compact to help the biomedical community become better acquainted with its mixed waste streams, to help minimize the mixed waste streams generated by the biomedical community, and to provide applicable treatment technologies to those particular mixed waste streams. Mixed waste is waste that satisfies the definition of low-level radioactive waste (LLW) in the Low-Level Radioactive Waste Policy Act of 1980 (LLRWPA) and contains hazardous waste that either (a) is listed as a hazardous waste in Subpart D of 40 CFR 261, or (b) causes the LLW to exhibit any of the hazardous waste characteristics identified in 40 CFR 261. The purpose of this report is to clearly define and characterize the mixed waste streams generated by the biomedical community so that an identification can be made of the waste streams that can and cannot be minimized and treated by current options. An understanding of the processes and complexities of generation of mixed waste in the biomedical community may encourage more treatment and storage options to become available.

28817 (DOE/LLW–221) **Impact assessment of draft DOE Order 5820.2B. Radioactive Waste Technical Support Program.** Lockheed Idaho Technologies Co., Idaho Falls, ID (United States). Apr 1995. 40p. Sponsored by USDOE, Washington, DC (United States). DOE Contract AC07-94ID13223. Order Number DE95017657. Source: OSTI; NTIS; INIS; GPO Dep.

The Department of Energy (DOE) has prepared a revision to DOE Order 5820.2A, entitled "Radioactive Waste Management." DOE issued DOE Order 5820.2A in September 1988 and, as the title implies, it covered only radioactive waste forms. The proposed draft order, entitled "Waste Management," addresses the management of both radioactive and nonradioactive waste forms. It also includes spent nuclear fuel, which DOE does not consider a waste. Waste forms covered include hazardous waste, high-level waste, transuranic (TRU) waste, low-level radioactive waste, uranium and thorium mill tailings, mixed waste, and sanitary waste. The Radioactive Waste Technical Support Program (TSP) of Leached Idaho Technologies Company (LITCO) is facilitating the revision of this order. The EM Regulatory Compliance Division (EM-331) has requested that TSP estimate the impacts and costs of compliance with the revised order. TSP requested Dames & Moore to aid in this assessment by comparing requirements in Draft Order 5820.2B to ones in DOE Order 5820.2A and other DOE orders and Federal regulations. The assessment started with a draft version of 5820.2B dated January 14, 1994. DOE has released three updated versions of the draft order since then (dated May 20, 1994; August 26, 1994; and January 23, 1995). Each time DOE revised the order, Dames and Moore updated the assessment work to reflect the text changes. This report reflects the January 23, 1995 version of the draft order.

28818 (DOE/MC/30361–95/C0498) **Development of components for waste management systems using aerospace technology.** Rousar, D. (Aerojet-General Corp., Sacramento, CA (United States)); Young, M.; Sieger, A. Aerojet-General Corp., Sacramento, CA (United States); Sandia National Labs., Albuquerque, NM (United States). [1995]. 11p. Sponsored by USDOE, Washington, DC (United States). DOE Contract AR21-93MC30361 ; AC04-94AL85000. (CONF-9510219–1: 46. international astronautical congress, Oslo (Norway), 2-6 Oct 1995). Order Number DE95017866. Source: OSTI; NTIS; GPO Dep.

An aerospace fluid management technology called "platelets" has been applied to components that are critical to the economic operation of waste management systems. Platelet devices are made by diffusion bonding thin metal plates which have been etched with precise flow passage circuitry to control and meter fluid to desired locations. Supercritical water oxidation (SCWO) is a promising waste treatment technology for safe and environmentally acceptable destruction of hazardous wastes. Performance and economics of current SCWO systems are limited by severe salt deposition on and corrosion of the reactor walls. A platelet transpiring-wall reactor has been developed that provides a protective layer of water adjacent to the reactor walls which prevents salt deposition and corrosion. Plasma arc processing is being considered as a method for stabilizing mixed radioactive wastes. Plasma arc torch systems currently require frequent shutdown to replace failed electrodes and this increases operating costs. A platelet electrode design was developed that has more than 10 times the life of conventional electrodes. It has water cooling channels internal to the electrode wall and slots through the wall for injecting gas into the arc.

28819 (DOE/MC/30361–4087) **Platelet-cooled plasma arc torch. Final report.** Aerojet-General Corp., Sacramento, CA (United States). Oct 1995. 210p. Sponsored by USDOE, Washington, DC (United States). DOE Contract AR21-93MC30361. Order Number DE95009734. Source: OSTI; NTIS; INIS; GPO Dep.

In this 12-month program sponsored by the DOE Morgantown Energy Technology Center, Aerojet designed, fabricated, and tested six platelet cooled electrodes for a Retech 75T (90 MW) plasma arc torch capable of processing mixed radioactive waste. Two of the electrodes with gas injection through the electrode wall

demonstrated between eight and forty times the life of conventional water cooled electrodes. If a similar life increase can be produced in a 1 Mw size electrode, then electrodes possessing thousands, rather than hundreds, of hours of life will be available to DOE for potential application to mixed radioactive waste processing.

28820 (DOE/OR/21400–T495) **Heat transfer enhanced microwave process for stabilization of liquid radioactive waste slurry. Final report.** White, T.L. Oak Ridge National Lab., TN (United States). 31 Mar 1995. 13p. Sponsored by USDOE, Washington, DC (United States). DOE Contract AC05-84OR21400. Order Number DE96000676. Source: OSTI; NTIS; INIS; GPO Dep.

The objectve of this CRADA is to combine a polymer process for encapsulation of liquid radioactive waste slurry developed by Monolith Technology, Inc. (MTI), with an in-drum microwave process for drying radioactive wastes developed by Oak Ridge National Laboratory (ORNL), for the purpose of achieving a fast, cost-effectve commercial process for solidification of liquid radioactive waste slurry. Tests performed so far show a four-fold increase in process throughput due to the direct microwave heating of the polymer/slurry mixture, compared to conventional edge-heating of the mixer. We measured a steady-state throughput of 33 ml/min for 1.4 kW of absorbed microwave power. The final waste form is a solid monolith with no free liquids and no free particulates.

28821 (DOE/OR/21400–T498) **Design and fabrication of a prototype sensor system for waste storage tank characterization. CRADA final report for CRADA Number ORNL92-0094.** Burks, B.L. (Oak Ridge National Lab., TN (United States)); Wagner, J. Oak Ridge National Lab., TN (United States). 8 Dec 1994. 8p. Sponsored by USDOE, Washington, DC (United States). DOE Contract AC05-84OR21400. Order Number DE96000679. Source: OSTI; NTIS; INIS; GPO Dep.

On February 15–16 1994, ORNL and MTI presented a technology demonstration showcasing the results of a CRADA between the two organizations. The CRADA project entailed design and development of a structured light mapping system suitable for deployment in underground waste storage tanks. The CRADA expanded upon a system previously designed and deployed at the DOE Fernald site by ORNL. Enhancements in the new system include: a factor of ten increase in mapping speed; radiation and environmental hardening sufficient for use in the Hanford single-shell tanks (up to 5,000 rad/hr, pH = 12, high heat, etc.); capability to map and display data for both vertical surfaces, such as pipes, and horizontal surfaces; rugged, compact design that can be deployed through a ten centimeter riser; and a design that can be decontaminated easily after deployment.

28822 (DOE/RL–94-96-Rev.1) **Hanford Site Pollution Prevention Plan progress report, 1994. Revision 1.** Westinghouse Hanford Co., Richland, WA (United States). Sep 1995. 150p. Sponsored by USDOE, Washington, DC (United States). DOE Contract AC06-87RL10930. Order Number DE96001068. Source: OSTI; NTIS; INIS; GPO Dep.

This report tracks progress made during 1994 against the goals stated in DOE/RL-92-62, Executive Summary, Hanford Site Pollution Prevention Plan. The Executive Summary of the plan was submitted to the Washington State Department of Ecology (Ecology) in September 1992. The plan, Executive Summary, and the progress reports are elements of a pollution prevention planning program that is required by WAC 173-307, "Plans," for all hazardous substance users and/or all hazardous waste generators regulated by Ecology. These regulations implement RCW 70.95C, "Waste Reduction," an act relating to hazardous waste reduction. The act encourages voluntary efforts to redesign industrial processes to help reduce or eliminate hazardous substances and hazardous waste byproducts, and to maximize the in-process reuse or reclamation of valuable spent material. The Hanford Site is voluntarily complying with this state regulatory-mandated program. All treatment, storage, or disposal (TSD) facilities are exempt from participating; the Hanford Site is classified as a TSD.

28823 (DOE/RL–94-104) **Description of work for vadose zone characterization of the 1301-N and 1325-N liquid waste disposal facilities.** USDOE Richland Operations Office, WA (United States); Bechtel National, Inc., Richland, WA (United States). Sep 1995. 60p. Sponsored by USDOE, Washington, DC (United States). DOE Contract AC06-93RL12367. Order Number DE96000284. Source: OSTI; NTIS; INIS; GPO Dep.

This description of work (DOW) details the field activities associated with a limited field investigation (LFI) of soil contamination beneath the 1301-N and 1325-N Liquid Waste Disposal Facilities (LWDFs), and will serve as a field guide for those performing the work. These activities are undertaken pursuant to the Hanford Federal Facility Agreement and consent Order (Tri-Party Agreement) (Ecology et al. 1994a) Milestone M-16-94-01H-T1 and the June 30, 1994, Milestone Change Request M-16-94-02 (Ecology et al. 1994b). The scope of these activities was defined during a Streamlined Approach for Environmental Restoration (SAFER) workshop and a US Department of Energy, Richland Operations Office (RL) workshop where data quality objectives (DQOs) and technical criteria for the LFI were developed. Results of the SAFER workshop are discussed in Section 1.1. the locations of the 1301-N and 1325-N LWDFs (116-N-1 and 116-N-3) are shown in Figure 1. Both the 1301-N and 1325-N LWDFs consist o a crib and a trench. Both LWDFs were used to receive and dispose of the cooling water originating from the 100-N Reactor and are classified as RCRA treatment, storage, and/or disposal (TSD) units. The LWDFs are no longer receiving waste effluent. Although these facilities are classified as RCRA TSD units, the RL and regulatory agencies have determined that this LFI will be conducted as a past-practice investigation under the auspices of the Comprehensive Environmental Response, Compensation, and Liability Act of 1980 (CERCLA), in accordance with the Hanford Site Past-Practice Investigation Strategy (DOE-RL 1991) and the 100-NR-1 Operable Unit RFI/CMS Work Plan (DOE-RL 1994).

28824 (DOE/RL–95-38) **Approach and plan for cleanup actions in the 100-FR-2 operable unit of the Hanford Site, Revision 0.** USDOE Richland Operations Office, WA (United States). Jun 1995. 11p. Sponsored by USDOE, Washington, DC (United States). DOE Contract AC06-93RL12367. Order Number DE95017514. Source: OSTI; NTIS; INIS; GPO Dep.

A new administrative approach is being used to reach a cleanup decision for the 100-FR-2 Operable Unit. The unit, located at the 100-F Area, contains solid waste sites and is one of the remaining operable units scheduled for characterization and cleanup in the 100 Area. This Focus Package (1) describes the new approach and activities needed to reach a decision on cleanup actions for the 100-FR-2 Operable Unit and (2) invites public participation into the planning process. The previous approach included the production of a Work Plan, a Limited Field Investigation Report, a Qualitative Risk Assessment, a Focused Feasibility Study, and a Proposed Plan, all culminating in an interim action Record of Decision. Information gathered to date on other operable units allows the analgous site approach to be used on the 100-FR-2 Operable Unit, and therefore, a reduction in documentation preparation. The U.S. Environmental Protection Agency, Washington State Department of Ecology, and the U.S. Department of Energy (Tri-Party Agreement) believe that the new approach will save time and funding. In the new approach, the Work Plan has been condensed into this 12 page Focus Package. The Focus Package includes a summary of 100-F Area information, a list of waste sites in the 100-FR-2 Operable Unit, a summary of proposed work, and a schedule. The new approach will also combine the Limited Field Investigation and Qualitative Risk Assessment reports into the Focused Feasibility Study. The Focused Feasibility Study will analyze methods and costs to clean up waste sites. Consolidating the documents should reduce the time to complete the Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA) process by 16 months, compared to the previous approach.

28825 (DOE/RW–0253-Rev.5) **Program cost and schedule baseline. Revision 5, (A00000000-00811-1701-00001).** USDOE Office of Civilian Radioactive Waste Management, Washington, DC (United States). Sep 1995. 50p. Sponsored by USDOE, Washington, DC (United States). Order Number DE96000815. Source: OSTI; NTIS; GPO Dep.

The purpose of this document is to establish quantitative expressions of proposed costs and schedule to serve as a basis for

measurement of Program performance. It identifies the components of the Program Cost and Schedule Baseline (PCSB) that will be subject to chance control by the Executive (Level 0) and Program (Level 1) Baseline Change Control Boards (BCCBs) and establishes their baseline values. The Program technical baseline is contained in the Civilian Radioactive Waste Management System (CRWMS) Requirements Document (CRD) and the System Requirement Documents (SRDs) for the individual system elements. Changes to the PCSB will be approved by the Program Baseline Change Control Board (PBCCB). In addition to the PBCCB, the Energy System Acquisition Advisory Board Baseline Change Control Board (ESAAB BCCB) will perform control functions relating to Total Project Cost (TPC) and major schedule milestones for the Yucca Mountain Site Characterization Project, the Waste Acceptance, Storage and Transportation (WAST) Project (formerly Monitored Retrievable Storage (MRS) Project), and Program Integration element.

28826 (DOE/RW–0477) **Site characterization progress report: Yucca Mountain, Nevada, October 1, 1994–March 31, 1995, Number 12. Nuclear Waste Policy Act (Section 113).** USDOE Office of Civilian Radioactive Waste Management, Washington, DC (United States). Aug 1995. 600p. Sponsored by USDOE, Washington, DC (United States). Order Number DE96000156. Source: OSTI; NTIS; INIS; GPO Dep.

During the first half of fiscal year 1995, most activities at the Yucca Mountain Site Characterization Project were directed at implementing the Program Plan developed by the Office of Civilian Radioactive Waste Management. The Plan is designed to enable the Office to make measurable and significant progress toward key objectives over the next five years within the financial resources that can be realistically expected. Activities this period focused on the immediate goal of determining by 1998 whether Yucca Mountain, Nevada, is technically suitable as a possible site for a geologic repository for the permanent disposal of spent nuclear fuel and high-level radioactive waste. Work on the Project advanced in several critical areas, including programmatic activities such as issuing the Program Plan, completing the first technical basis report to support the assessment of three 10 CFR 960 guidelines, developing the Notice of Intent for the Environmental Impact Statement, submitting the License Application Annotated Outline, and beginning a rebaselining effort to conform with the goals of the Program Plan. Scientific investigation and analysis of the site and design and construction activities to support the evaluation of the technical suitability of the site also advanced. Specific details relating to all Project activities and reports generated are presented in this report.

28827 (DOE/SR/18445–T2) **Infrastructure support for the Waste Management Institute. Progress report.** North Carolina Agricultural and Technical State Univ., Greensboro, NC (United States). 27 Jun 1995. 50p. Sponsored by USDOE, Washington, DC (United States). DOE Contract FG09-94SR18445. Order Number DE95014297. Source: OSTI; NTIS; INIS; GPO Dep.

North Carolina A&T State University is in the process of developing an infrastructure for an interdisciplinary Waste Management Institute (WMI). The Interdisciplinary Waste Management Institute (WMI) was approved in June 1994 by the General Administration of the University of North Carolina as an academic support unit with research and public service functions. The mission of the WMI is to enhance awareness and understanding of waste management issues and to provide instructional support including research and outreach. The goals of WMI are as follows: increase the number of minority professionals who will work in waste management fields; develop cooperative and exchange programs involving faculty, students, government, and industry; serve as institutional sponsor of public awareness workshops and lecture series; and support interdisciplinary research programs. Accomplishments for this reporting period are presented for WMI enrollment; waste management and certificate program; waste management instructional projects; undergraduate scholarship/stipend and faculty student development projects; research; and community relations.

28828 (INEL–94/0095) **Modeling of thermal plasma arc technology FY 1994 report.** Hawkes, G.L.; Nguyen, H.D.; Paik, S.; McKellar, M.G. Idaho National Engineering Lab., Idaho Falls, ID (United States). Mar 1995. 98p. Sponsored by USDOE, Washington, DC (United States). DOE Contract AC07-94ID13223. Order Number DE96001325. Source: OSTI; NTIS; INIS; GPO Dep.

The thermal plasma arc process is under consideration to thermally treat hazardous and radioactive waste. A computer model for the thermal plasma arc technology was designed as a tool to aid in the development and use of the plasma arc-Joule beating process. The value of this computer model is to: (a) aid in understanding the plasma arc-Joule beating process as applied to buried waste or exhumed buried waste, (b) help design melter geometry and electrode configuration, (c) calculate the process capability of vitrifying waste (i.e., tons/hour), (d) develop efficient plasma and melter operating conditions to optimize the process and/or reduce safety hazards, (e) calculate chemical reactions during treatment of waste to track chemical composition of off-gas products, and composition of final vitrified waste form and (f) help compare the designs of different plasma-arc facilities. A steady-state model of a two-dimensional axisymmetric transferred plasma arc has been developed and validated. A parametric analysis was performed that studied the effects of arc length, plasma gas composition, and input power on the temperatures and velocity profiles of the slag and plasma gas. A two-dimensional transient thermo-fluid model of the US Bureau of Mines plasma arc melter has been developed. This model includes the growth of a slag pool. The thermo-fluid model is used to predict the temperature and pressure fields within a plasma arc furnace. An analysis was performed to determine the effects of a molten metal pool on the temperature, velocity, and voltage fields within the slag. A robust and accurate model for the chemical equilibrium calculations has been selected to determine chemical composition of final waste form and off-gas based on the temperatures and pressures within the plasma-arc furnace. A chemical database has been selected. The database is based on the materials to be processed in the plasma arc furnaces.

28829 (INEL–94/0119) **ICPP radioactive liquid and calcine waste technologies evaluation final report and recommendation.** Lockheed Idaho Technologies Co., Idaho Falls, ID (United States). Apr 1995. 200p. Sponsored by USDOE, Washington, DC (United States). DOE Contract AC07-94ID13223. Order Number DE96001338. Source: OSTI; NTIS; INIS; GPO Dep.

Using a formalized Systems Engineering approach, the Latched Idaho Technologies Company developed and evaluated numerous alternatives for treating, immobilizing, and disposing of radioactive liquid and calcine wastes at the Idaho Chemical Processing Plant. Based on technical analysis data as of March, 1995, it is recommended that the Department of Energy consider a phased processing approach – utilizing Radionuclide Partitioning for radioactive liquid and calcine waste treatment, FUETAP Grout for low-activity waste immobilization, and Glass (Vitrification) for high-activity waste immobilization – as the preferred treatment and immobilization alternative.

28830 (INEL–94/00120) **Slag recycling of irradiated vanadium.** Gorman, P.K. EG and G Idaho, Inc., Idaho Falls, ID (United States). 5 Apr 1995. 100p. Sponsored by USDOE, Washington, DC (United States). DOE Contract AC07-76ID01570. Order Number DE96001441. Source: OSTI; NTIS; INIS; GPO Dep.

An experimental inductoslag apparatus to recycle irradiated vanadium was fabricated and tested. An experimental electroslag apparatus was also used to test possible slags. The testing was carried out with slag materials that were fabricated along with impurity bearing vanadium samples. Results obtained include computer simulated thermochemical calculations and experimentally determined removal efficiencies of the transmutation impurities. Analyses of the samples before and after testing were carried out to determine if the slag did indeed remove the transmutation impurities from the irradiated vanadium.

28831 (INEL–95/0013) **Waste Management Facilities cost information for low-level waste.** Shropshire, D.; Sherick, M.; Biadgi, C. Lockheed Idaho Technologies Co., Idaho Falls, ID (United States). Jun 1995. 300p. Sponsored by USDOE, Washington, DC (United States). DOE Contract AC07-94ID13223. Order Number DE96001353. Source: OSTI; NTIS; INIS; GPO Dep.

This report contains preconceptual designs and planning level life-cycle cost estimates for managing low-level waste. The report's

information on treatment, storage, and disposal modules can be integrated to develop total life-cycle costs for various waste management options. A procedure to guide the US Department of Energy and its contractor personnel in the use of cost estimation data is also summarized in this report.

28832 (INEL–95/0014-Rev.1) **Waste Management Facilities cost information for mixed low-level waste. Revision 1.** Shropshire, D.; Sherick, M.; Biadgi, C. Lockheed Idaho Technologies Co., Idaho Falls, ID (United States). Jun 1995. 350p. Sponsored by USDOE, Washington, DC (United States). DOE Contract AC07-94ID13223. Order Number DE96001352. Source: OSTI; NTIS; INIS; GPO Dep.

This report contains preconceptual designs and planning level life-cycle cost estimates for managing mixed low-level waste. The report's information on treatment, storage, and disposal modules can be integrated to develop total life-cycle costs for various waste management options. A procedure to guide the US Department of Energy and its contractor personnel in the use of cost estimation data is also summarized in this report.

28833 (INEL–95/0016-Rev.1) **Waste management facilities cost information for hazardous waste. Revision 1.** Shropshire, D.; Sherick, M.; Biagi, C. Lockheed Idaho Technologies Co., Idaho Falls, ID (United States). Jun 1995. 100p. Sponsored by USDOE, Washington, DC (United States). DOE Contract AC07-94ID13223. Order Number DE96001351. Source: OSTI; NTIS; INIS; GPO Dep.

This report contains preconceptual designs and planning level life-cycle cost estimates for managing hazardous waste. The report's information on treatment, storage, and disposal modules can be integrated to develop total life-cycle costs for various waste management options. A procedure to guide the US Department of Energy and its contractor personnel in the use of cost estimation data is also summarized in this report.

28834 (INEL–95/0036) **Results of performance tests on chemical and radiation measurement systems for use at a dig-face.** Gehrke, R.J.; Lawrence, R.S.; Pawelko, R.J. Idaho National Engineering Lab., Idaho Falls, ID (United States). Apr 1995. 120p. Sponsored by USDOE, Washington, DC (United States). DOE Contract AC07-94ID13223. Order Number DE96001183. Source: OSTI; NTIS; INIS; GPO Dep.

Chemical and radiation measurement systems are being developed for use at a dig-face to provide sensing capability during the excavation of previously buried waste. it is believed that on-line dig-face characterization will reduce environmental, health, and safety risks during the cleanup of buried waste sites as well as improve the efficiency of the cleanup process. This report describes progress in the development of three measurement systems: (a) a γ/neutron monitor that scans the dig-face for high levels of radiation prior to excavation, (b) a Ge spectrometer that identifies specific radionuclides located with the γ/neutron monitor, and (c) a prompt γ neutron activation analysis (PGNAA) system that measures the presence of chlorine and chlorinated compounds often associated with hazardous waste. The Ge spectrometer and PGNAA system also will provide off-line but on-site capability of radionuclide and elemental identification of excavated waste prior to handling, treatment, transportation, or disposal.

28835 (INEL–95/0054) **Advanced Mixed Waste Treatment Project melter system preliminary design technical review meeting.** Eddy, T.L.; Raivo, B.D.; Soelberg, N.R.; Wiersholm, O. Fermi National Accelerator Lab., Batavia, IL (United States). Feb 1995. 200p. Sponsored by USDOE, Washington, DC (United States). DOE Contract AC07-94ID13223. Order Number DE96001189. Source: OSTI; NTIS; INIS; GPO Dep.

The Idaho National Engineering Laboratory Advanced Mixed Waste Treatment Project sponsored a plasma are melter technical design review meeting to evaluate high-temperature melter system configurations for processing heterogeneous alpha-contaminated low-level radioactive waste (ALLW). Thermal processing experts representing Department of Energy contractors, the Environmental Protection Agency, and private sector companies participated in the review. The participants discussed issues and evaluated alternative configurations for three areas of the melter system design: plasma torch melters and graphite arc melters, offgas treatment options, and overall system configuration considerations. The Technical Advisory Committee for the review concluded that graphite arc melters are preferred over plasma torch melters for processing ALLW. Initiating involvement of stakeholders was considered essential at this stage of the design. For the offgas treatment system, the advisory committee raised the question whether to a use wet-dry or a dry-wet system. The committee recommended that the waste stream characterization, feed preparation, and the control system are essential design tasks for the high-temperature melter treatment system. The participants strongly recommended that a complete melter treatment system be assembled to conduct tests with nonradioactive surrogate waste material. A nonradioactive test bed would allow for inexpensive design and operational changes prior to assembling a system for radioactive waste treatment operations.

28836 (INEL–95/0114) **Catalog of documents produced by the Greater-Than-Class C Low-Level Waste Management Program.** Winberg, M.R. Lockheed Idaho Technologies Co., Idaho Falls, ID (United States). Mar 1995. 74p. Sponsored by USDOE, Washington, DC (United States). DOE Contract AC07-94ID13223. Order Number DE96001356. Source: OSTI; NTIS; INIS; GPO Dep.

This catalog provides a ready reference for documents prepared by the Greater-Than-Class C Low-Level Waste (GTCC LLW) Management Program. The GTCC LLW Management Program is part of the National Low-Level Waste Management Program (NLLWMP). The NLLWMP is sponsored by the US Department of Energy (DOE) and is responsible for assisting the DOE in meeting its obligations under Public Law 99-240, The Low-Level Radioactive Waste Policy Amendments Act of 1985. This law assigns DOE the responsibility of ensuring the safe disposal of GTCC LLW in a facility licensed by the Nuclear Regulatory Commission (NRC). The NLLWMP is managed at the Idaho National Engineering Laboratory (INEL).

28837 (INEL–95/0129) **Integrated thermal treatment system sudy: Phase 2, Results.** Feizollahi, F.; Quapp, W.J. Idaho National Engineering Lab., Idaho Falls, ID (United States). Aug 1995. 405p. Sponsored by USDOE, Washington, DC (United States). DOE Contract AC07-94ID13223. Order Number DE96000981. Source: OSTI; NTIS; INIS; GPO Dep.

This report presents the second phase of a study on thermal treatment technologies. The study consists of a systematic assessment of nineteen thermal treatment alternatives for the contact-handled mixed low-level waste (MLLW) currently stored in the US Department of Energy complex. The treatment alternatives consist of widely varying technologies for safely destroying the hazardous organic components, reducing the volume, and preparing for final disposal of the MLLW. The alternatives considered in Phase 2 were innovative thermal treatments with nine types of primary processing units. Other variations in the study examined the effect of combustion gas, air pollution control system design, and stabilization technology for the treatment residues. The Phase 1 study, the results of which have been published as an interim report, examined ten initial thermal treatment alternatives. The Phase 2 systems were evaluated in essentially the same manner as the Phase 2 systems. The assumptions and methods were the same as for the Phase 1 study. The quantities, and physical and chemical compositions, of the input waste used in he Phase 2 systems differ from those in the Phase 1 systems, which were based on a preliminary waste input database developed at the onset of the Integrated Thermal Treatment System study. The inventory database used in the Phase 2 study incorporates the latest US Department of Energy information. All systems, both primary treatment systems and subsystem inputs, have now been evaluated using the same waste input (2,927 lb/hr).

28838 (INEL–95/00137) **Life cycle cost estimation and systems analysis of Waste Management Facilities.** Shropshire, D. (Lockheed Idaho Technologies Co., Idaho Falls, ID (United States)); Feizollahi, F. Lockheed Idaho Technologies Co., Idaho Falls, ID (United States). [1995]. 12p. Sponsored by USDOE, Washington, DC (United States). DOE Contract AC07-94ID13223. (CONF-950917–14: 5. international conference on radioactive waste management and environmental remediation, Berlin (Germany), 3-9 Sep 1995). Order Number DE96001615. Source: OSTI; NTIS; INIS; GPO Dep.

This paper presents general conclusions from application of a system cost analysis method developed by the United States Department of Energy (DOE), Waste Management Division (WM), Waste Management Facilities Costs Information (WMFCI) program. The WMFCI method has been used to assess the DOE complex-wide management of radioactive, hazardous, and mixed wastes. The Idaho Engineering Laboratory, along with its subcontractor Morrison Knudsen Corporation, has been responsible for developing and applying the WMFCI cost analysis method. The cost analyses are based on system planning level life-cycle costs. The costs for life-cycle waste management activities estimated by WMFCI range from bench-scale testing and developmental work needed to design and construct a facility, facility permitting and startup, operation and maintenance, to the final decontamination, decommissioning, and closure of the facility. For DOE complex-wide assessments, cost estimates have been developed at the treatment, storage, and disposal module level and rolled up for each DOE installation. Discussions include conclusions reached by studies covering complex-wide consolidation of treatment, storage, and disposal facilities, system cost modeling, system costs sensitivity, system cost optimization, and the integration of WM waste with the environmental restoration and decontamination and decommissioning secondary wastes.

28839 (INEL–95/0161) **Emissions model of waste treatment operations at the Idaho Chemical Processing Plant.** Schindler, R.E. Fermi National Accelerator Lab., Batavia, IL (United States). Mar 1995. 75p. Sponsored by USDOE, Washington, DC (United States). DOE Contract AC07-94ID13223. Order Number DE96001181. Source: OSTI; NTIS; INIS; GPO Dep.

An integrated model of the waste treatment systems at the Idaho Chemical Processing Plant (ICPP) was developed using a commercially-available process simulation software (ASPEN Plus) to calculate atmospheric emissions of hazardous chemicals for use in an application for an environmental permit to operate (PTO). The processes covered by the model are the Process Equipment Waste evaporator, High Level Liquid Waste evaporator, New Waste Calcining Facility and Liquid Effluent Treatment and Disposal facility. The processes are described along with the model and its assumptions. The model calculates emissions of NO_x, CO, volatile acids, hazardous metals, and organic chemicals. Some calculated relative emissions are summarized and insights on building simulations are discussed.

28840 (INEL–95/0164) **Measurement of VOC permeability of polymer bags and VOC solubility in polyethylene drum liner.** Liekhus, K.J.; Peterson, E.S. Fermi National Accelerator Lab., Batavia, IL (United States). Mar 1995. 50p. Sponsored by USDOE, Washington, DC (United States). DOE Contract AC07-94ID13223. Order Number DE96001180. Source: OSTI; NTIS; INIS; GPO Dep.

A test program conducted at the Idaho National Engineering Laboratory (INEL) investigated the use of a transport model to estimate the volatile organic compound (VOC) concentration in the void volume of a waste drum. Unsteady-state VOC transport model equations account for VOC permeation of polymer bags, VOC diffusion across openings in layers of confinement, and VOC solubility in a polyethylene drum liner. In support of this program, the VOC permeability of polymer bags and VOC equilibrium concentration in a polyethylene drum liner were measured for nine VOCs. The VOCs used in experiments were dichloromethane, carbon tetrachloride, cyclohexane, toluene, 1,1,1-trichloroethane, methanol, 1,1,2-trichloro-1,2,2-trifluoroethane (Freon-113), trichloroethylene, and p-xylene. The experimental results of these measurements as well as a method of estimating both parameters in the absence of experimental data are described in this report.

28841 (INEL–95/0194) **Reliability evaluation methodologies for ensuring container integrity of stored transuranic (TRU) waste.** Smith, K.L. Lockheed Idaho Technologies Co., Idaho Falls, ID (United States). Jun 1995. 50p. Sponsored by USDOE, Washington, DC (United States). DOE Contract AC07-94ID13223. Order Number DE96001339. Source: OSTI; NTIS; INIS; GPO Dep.

This report provides methodologies for providing defensible estimates of expected transuranic waste storage container lifetimes at the Radioactive Waste Management Complex. These methodologies can be used to estimate transuranic waste container reliability (for integrity and degradation) and as an analytical tool to optimize waste container integrity. Container packaging and storage configurations, which directly affect waste container integrity, are also addressed. The methodologies presented provide a means for demonstrating Resource Conservation and Recovery Act waste storage requirements.

28842 (INEL–95/0224) **TRUEX partitioning from radioactive ICPP sodium bearing waste.** Herbst, R.S.; Brewer, K.N.; Tranter, T.J.; Todd, T.A. Fermi National Accelerator Lab., Batavia, IL (United States). Mar 1995. 23p. Sponsored by USDOE, Washington, DC (United States). DOE Contract AC07-94ID13223. Order Number DE96001188. Source: OSTI; NTIS; INIS; GPO Dep.

The Idaho Chemical Processing Plant (ICPP) located at the Idaho National Engineering Laboratory in Southeast Idaho is currently evaluating several treatment technologies applicable to waste streams generated over several decades of-nuclear fuel reprocessing. Liquid sodium bearing waste (SBW), generated primarily during decontamination activities, is one of the waste streams of interest. The TRansUranic EXtraction (TRUEX) process developed at Argonne National Laboratory is currently being evaluated to separate the actinides from SBW. On a mass basis, the amount of the radioactive species in SBW are low relative to inert matrix components. Thus, the advantage of separations is a dramatic decrease in resulting volumes of high activity waste (HAW) which must be dispositioned. Numerous studies conducted at the ICPP indicate the applicability of the TRUEX process has been demonstrated; however, these studies relied on a simulated SBW surrogate for the real waste. Consequently, a series of batch contacts were performed on samples of radioactive ICPP SBW taken from tank WM-185 to verify that actual waste would behave similarly to the simulated waste. The test results with SBW from tank WM-185 indicate the TRUEX solvent effectively extracts the actinides from the samples of actual waste. Gross alpha radioactivity, attributed predominantly to Pu and Am, was reduced from 3.14E+04 dps/mL to 1.46 dps/mL in three successive batch contacts with fresh TRUEX solvent. This reduction corresponds to a decontamination factor of DF = 20,000 or 99.995% removal of the gross a activity in the feed. The TRUEX solvent also extracted the matrix components Zr, Fe, and Hg to an appreciable extent ($D_{Zr} > 10$, $D_{Fe} \approx 2$, $D_{Hg} \approx 6$). Iron co-extracted with the actinides can be successfully scrubbed from the organic with 0.2 M HNO_3. Mercury can be selectively partitioned from the actinides with either sodium carbonate or nitric acid ($\geq$ 5 M HNO_3) solutions.

28843 (INEL–95/0225) **Actinide partitioning from actual ICPP dissolved zirconium calcine using the TRUEX solvent.** Brewer, K.N. (and others); Herbst, R.S.; Tranter, T.J. Fermi National Accelerator Lab., Batavia, IL (United States). May 1995. 39p. Sponsored by USDOE, Washington, DC (United States). DOE Contract AC07-94ID13223. Order Number DE96001184. Source: OSTI; NTIS; INIS; GPO Dep.

The TRansUranic EXtraction process (TRUEX), as developed by E.P. Horwitz and coworkers at Argonne National Laboratory (ANL), is being evaluated as a TRU extraction process for Idaho Chemical Processing Plant (ICPP) wastes. A criteria that must be met during this evaluation, is that the aqueous raffinate must be below the 10 nCi/g limit specified in 10 CFR 61.55. A test was performed where the TRUEX solvent (0.2 M octyl(phenyl)-N-N-diisobutyl-carbamoylmethyl-phosphine oxide (CMPO), and 1.4 M tributylphosphate (TBP) in an Isopar-L diluent) was contacted with actual ICPP dissolved zirconium calcine. Two experimental flowsheets were used to determine TRU decontamination factors, and TRU, Zr, Fe, Cr, and Tc extraction, scrub, and strip distribution coefficients. Results from these two flowsheets show that >99.99% of the TRU alpha activity was removed from the acidic feed after three contacts with the TRUEX solvent (fresh solvent being used for each contact). The resulting aqueous raffinate solution contained an approximate TRU alpha activity of 0.02 nCi/g, which is well below the non-TRU waste limit of 10 nCi/g specified in 10 CFR 61.55. Favorable scrub and strip distribution coefficients were also observed for Am-241, Pu-238, and Pu-239, indicating the feasibility of recovering these isotopes from the TRUTEX solvent. A solution of 0.04 M 1-hydroxyethane-1,1-diphosphonic acid (HEDPA) in 0.04 M HNO_3 was used to successfully strip the TRUs

from the TRUEX solvent. The results of the test using actual ICPP dissolved zirconium calcine, and subsequent GTM evaluation, show the feasibility of removing TRUs from the dissolved zirconium calcine with the TRUEX solvent and the deleterious effects zirconium poses with the ICPP zirconium calcine waste. Test results using actual ICPP zirconium calcine reveal the necessity of preventing zirconium from following the TRUs.

28844 (INEL–95/0272) **Lead use and recycling at the INEL.** Losinski, S.J.; Thurmond, S.M. Lockheed Idaho Technologies Co., Idaho Falls, ID (United States). Aug 1995. 9p. Sponsored by USDOE, Washington, DC (United States). DOE Contract AC07-94ID13223. Order Number DE96001336. Source: OSTI; NTIS; INIS; GPO Dep.

As part of DOE's efforts to develop a Department-wide management strategy for the use, reuse, and recycle of lead, DOE has requested that each site provide site-specific management and use practices for lead, specifically management and use information that responds to four specific questions of interest. This report provides the Idaho National Engineering Laboratory's response to those areas of interest.

28845 (INEL–95/0273) **System cost model user's manual, version 1.2.** Shropshire, D. EG and G Idaho, Inc., Idaho Falls, ID (United States). Jun 1995. 148p. Sponsored by USDOE, Washington, DC (United States). DOE Contract AC07-94ID13223. Order Number DE96001354. Source: OSTI; NTIS; INIS; GPO Dep.

The System Cost Model (SCM) was developed by Lockheed Martin Idaho Technologies in Idaho Falls, Idaho and MK-Environmental Services in San Francisco, California to support the Baseline Environmental Management Report sensitivity analysis for the U.S. Department of Energy (DOE). The SCM serves the needs of the entire DOE complex for treatment, storage, and disposal (TSD) of mixed low-level, low-level, and transuranic waste. The model can be used to evaluate total complex costs based on various configuration options or to evaluate site-specific options. The site-specific cost estimates are based on generic assumptions such as waste loads and densities, treatment processing schemes, existing facilities capacities and functions, storage and disposal requirements, schedules, and cost factors. The SCM allows customization of the data for detailed site-specific estimates. There are approximately forty TSD module designs that have been further customized to account for design differences for nonalpha, alpha, remote-handled, and transuranic wastes. The SCM generates cost profiles based on the model default parameters or customized user-defined input and also generates costs for transporting waste from generators to TSD sites.

28846 (INEL–95/0302) **Results of the gamma-neutron mapper performance test on 55-gallon drums at the RWMC.** Gehrke, R.J.; Lawrence, R.S.; Roybal, L.G.; Svoboda, J.M.; Harker, D.J.; Thompson, D.N.; Carpenter, M.V.; Josten, N.E. Lockheed Idaho Technologies Co., Idaho Falls, ID (United States). Jul 1995. 28p. Sponsored by USDOE, Washington, DC (United States). DOE Contract AC07-94ID13223. Order Number DE96001337. Source: OSTI; NTIS; INIS; GPO Dep.

The primary purpose of the gamma-neutron mapper (G@) is to provide accurate and quantitative spatial information of the gamma-ray and neutron radiation fields as a function of position about the excavation of a radioactive waste site. The GNM is designed to operate remotely and can be delivered to any point on an excavation by the robotic gantry crane developed by the dig-face project at the Idaho National Engineering Laboratory (INEL). It can also be easily adapted to other delivery systems. The GNM can be deployed over a waste site at a predetermined scan rate and has sufficient accuracy to identify and quantify radioactive contaminants of importance. The results reported herein are from a performance test conducted at the Transuranic Storage Area, Building 628, of the Radioactive Waste Management Complex located at the INEL. This building is an active interim-storage area for 55-gal drums of transuranic waste from the Department of Energy's Rocky Flats Plant. The performance test consisted of scanning a stack of drums five high by five wide. Prior to the test, radiation fields were measured by a health physicist at the center of the drums and ranged from 0.5 mR/h to 35 mR/h. Scans of the drums using the GNM were taken at standoff distances from the vertical drum stack of 15 cm, 30 cm, 45 cm, and 90 cm. Data were acquired at scan speeds of 7.5 cm/s and 15 cm/s. The results of these scans and a comparison of these results with the manifests of these drums are compared and discussed.

28847 (INEL–95/00320) **Commercial low-level radioactive waste disposal in the US.** Smith, P. Lockheed Idaho Technologies Co., Idaho Falls, ID (United States). [1995]. 5p. Sponsored by USDOE, Washington, DC (United States). DOE Contract AC07-94ID13223. (CONF-950787–86: 36. annual meeting of the Institute for Nuclear Materials Management, Palm Desert, CA (United States), 9-12 Jul 1995). Order Number DE96001612. Source: OSTI; NTIS; INIS; GPO Dep.

Why are 11 states attempting to develop new low-level radioactive waste disposal facilities? Why is only on disposal facility accepting waste nationally? What is the future of waste disposal? These questions are representative of those being asked throughout the country. This paper attempts to answer these questions in terms of where we are, how we got there, and where we might be going.

28848 (INEL–95/0321) **Buried Waste Integrated Demonstration fiscal Year 1994 close-out report.** Owen, K.J. Lockheed Idaho Technologies Co., Idaho Falls, ID (United States). Jul 1995. 90p. Sponsored by USDOE, Washington, DC (United States). DOE Contract AC07-94ID13223. Order Number DE96001335. Source: OSTI; NTIS; INIS; GPO Dep.

The Buried Waste integrated Demonstration (BWID) supports the applied research, development, demonstration, and evaluation of a multitude of advanced technologies. These technologies are being integrated to form a comprehensive remediation system for the effective and efficient remediation of buried waste. These efforts are identified and coordinated in support of the US Department of Energy Environmental Restoration and Waste Management needs and objectives. BWID works with universities and private industry to develop these technologies, which are being transferred to the private sector for use nationally and internationally. A public participation policy has been established to provide stakeholders with timely and accurate information and meaningful opportunities for involvement in the technology development and demonstration process. To accomplish this mission of identifying technological solutions for remediation deficiencies, the Department of Energy Office of Technology Development initiated BMD at the Idaho National Engineering Laboratory. This report summarizes the activities of the BWID program during Fiscal Year 1994. In Fiscal Year 1995, these activities are transitioning into the Landfill Stabilization Focus Area.

28849 (INEL–95/0414) **CMP flowsheet development for the separation of actinides from ICPP sodium-bearing waste using centrifugal contactors.** Law, J.D.; Herbst, R.S.; Rodriguez, A.M. Fermi National Accelerator Lab., Batavia, IL (United States). Aug 1995. 38p. Sponsored by USDOE, Washington, DC (United States). DOE Contract AC07-94ID13223. Order Number DE96001186. Source: OSTI; NTIS; INIS; GPO Dep.

Previous results of lab-scale batch contacts with sodium-bearing waste (SBW) simulant suggested a potential flowsheet for partitioning actinides using solvent extraction with dihexyl-N,N-diethylcarbamoylmethyl phosphonate (DHDECMP or simply CMP) as the extractant. The suggested baseline flowsheet includes: an extraction section to remove actinides from liquid SBW into the CMP solvent (0.75 M CMP, 1.0 M TBP in Isopar-L®); a thermally unstable complexant (TUCS) strip section to back-extract actinides; a sodium carbonate wash section for solvent cleanup; and a dilute HNO_3 rinse section to re-acidify the solvent. The purpose of these studies was to test and develop a baseline CMP flowsheet for Idaho Chemical Processing Plant (ICPP) SBW under continuous, countercurrent conditions using centrifugal contactors. This flowsheet was tested in two experiments using the Centrifugal Contactor Mockup which consists of sixteen stages of 5.5 cm diameter centrifugal contactors (procured from Oak Ridge National Laboratory). All testing was performed using non-radioactive SBW simulant. Potential flowsheets were evaluated with regard to the behavior of the non-radioactive components potentially extracted by the CMP solvent. Specifically, the behavior of the matrix components, including Fe, Hg, and Zr, was studied. In addition, Nd was added to the SBW simulant as a surrogate for ^{241}Am. In general,

the behavior of the individual components closely paralleled that anticipated from batch testing. Based on the assumption that the behavior of Am will be very similar to the behavior of the Nd surrogate, eight extraction stages are more than sufficient to reduce the actinide content in the SBW to levels well below the NRC Class A LLW criteria of 10 nCi/g. Very little Fe or Zr were extracted from the SBW simulant, resulting in only 1% of the Fe and 4% of the Zr exiting in the high-activity waste (HAW) fraction.

28850 (INEL–95/0442) **Nondestructive examination technologies for inspection of radioactive waste storage tanks.** Anderson, M.T.; Kunerth, D.C.; Davidson, J.R. Lockheed Idaho Technologies Co., Idaho Falls, ID (United States). Aug 1995. 30p. Sponsored by USDOE, Washington, DC (United States). DOE Contract AC07-94ID13223. Order Number DE96001334. Source: OSTI; NTIS; INIS; GPO Dep.

The evaluation of underground radioactive waste storage tank structural integrity poses a unique set of challenges. Radiation fields, limited access, personnel safety and internal structures are just some of the problems faced. To examine the internal surfaces a sensor suite must be deployed as an end effector on a robotic arm. The purpose of this report is to examine the potential failure modes of the tanks, rank the viability of various NDE technologies for internal surface evaluation, select a technology for initial EE implementation, and project future needs for NDE EE sensor suites.

28851 (INIS-mf–14561, pp. 75-80) **Modelling in situ porewater chemistries for low permeability Palfris marl.** Baeyens, B. (Paul Scherrer Inst. (PSI), Villigen (Switzerland)); Bradbury, M.H. [1995]. 125p. In *Paul Scherrer Institut annual report 1994. Annex IV: PSI nuclear energy and safety research progress report 1994.* Order Number DE96601628.

In a region of the Palfris marl formation at Wellenberg foreseen as the location for a low and intermediate level radioactive waste repository, the groundwater flow rates are so low that reliable water samples for chemical analysis could not be collected. Since the groundwater chemistry is an important basic data set in performance assessment, a physico-chemical characterisation procedure for determining porewater compositions was developed and applied to a Palfris marl sample. The laboratory measurements, coupled with geochemical modelling, yielded a Na-Cl type porewater with an ionic strength of $\simeq$0.1 M. In addition, a matrix marl porosity of $\simeq$1.5% was deduced using the chloride concentration in the calculated porewater and measurements on the chloride content of the marl. (author) 1 fig., 4 tabs., 12 refs.

28852 (INIS-mf–14561, pp. 81-93) **Efficient modelling of reactive transport phenomena by multi-species random-walk coupled to chemical equilibrium.** Pfingsten, W. (Paul Scherrer Inst. (PSI), Villigen (Switzerland)). [1995]. 125p. In *Paul Scherrer Institut annual report 1994. Annex IV: PSI nuclear energy and safety research progress report 1994.* Order Number DE96601628.

Reactive transport is modelled by the sequentially coupled code MCOTAC, that couples one-dimensional advective, dispersive and diffusive transport with chemical equilibrium complexation and precipitation/dissolution reactions in a porous medium. Transport, described by a random walk of multi-species particles, and chemical equilibrium calculations are solved separately, coupled only by an exchange term. The modular-structured code was applied to incongruent dissolution of hydrated silicate gels, to movement of multiple solid front systems and to an artificial, numerically difficult heterogeneous redox problem. These applications show promising features with respect to applicability to safety relevant problems and possibilities of extensions. (author) 9 figs., 6 tabs., 32 refs.

28853 (IS–5102-Exec.Summ.) **Federal Facility Compliance Act, Proposed Site Treatment Plan: Background Volume. Executive Summary.** Ames Lab., IA (United States). 24 Mar 1995. 30p. Sponsored by USDOE, Washington, DC (United States). DOE Contract W-7405-ENG-82. Order Number DE96000896. Source: OSTI; NTIS; INIS; GPO Dep.

This Federal Facility Compliance Act Site Treatment Plan discusses the options of radioactive waste management for Ames Laboratory. This is the background volume which discusses: site history and mission; framework for developing site treatment plans; proposed plan organization and related activities; characterization of mixed waste and waste minimization; low level mixed waste streams and the proposed treatment approach; future generation of TRU and mixed wastes; the adequacy of mixed waste storage facilities; and a summary of the overall DOE activity in the area of disposal of mixed waste treatment residuals.

28854 (IS–5102-Pt.1) **Federal Facilities Compliance Act, Conceptual Site Treatment Plan. Part 1.** Ames Lab., IA (United States). 29 Oct 1993. 243p. Sponsored by USDOE, Washington, DC (United States). DOE Contract W-7405-ENG-82. Order Number DE96000895. Source: OSTI; NTIS; INIS; GPO Dep.

This Conceptual Site Treatment Plan was prepared by Ames Laboratory to meet the requirements of the Federal Facilities Compliance Act. Topics discussed in this document include: general discussion of the plan, including the purpose and scope; technical aspects of preparing plans, including the rationale behind the treatability groupings and a discussion of characterization issues; treatment technology needs and treatment options for specific waste streams; low-level mixed waste options; TRU waste options; and future waste generation from restoration activities.

28855 (IS–5102-Pt.2-Vol.1) **Federal Facilities Compliance Act, Draft Site Treatment Plan: Background Volume, Part 2, Volume 1.** Ames Lab., IA (United States). 31 Aug 1994. 60p. Sponsored by USDOE, Washington, DC (United States). DOE Contract W-7405-ENG-82. Order Number DE96000897. Source: OSTI; NTIS; INIS; GPO Dep.

This Draft Site Treatment Plan was prepared by Ames Laboratory to meet the requirements of the Federal Facilities Compliance Act. Topics discussed include: purpose and scope of the plan; site history and mission; draft plant organization; waste minimization; waste characterization; preferred option selection process; technology for treating low-level radioactive wastes and TRU wastes; future generation of mixed waste streams; funding; and process for evaluating disposal issues in support of the site treatment plan.

28856 (IS–5102-Pt.2-Vol.2) **Federal Facilities Compliance Act, Draft Site Treatment Plan: Compliance Plan Volume. Part 2, Volume 2.** Ames Lab., IA (United States). 31 Aug 1994. 14p. Sponsored by USDOE, Washington, DC (United States). DOE Contract W-7405-ENG-82. Order Number DE96000898. Source: OSTI; NTIS; INIS; GPO Dep.

This document presents the details of the implementation of the Site Treatment Plan developed by Ames Laboratory in compliance with the Federal Facilities Compliance Act. Topics discussed in this document include: implementation of the plan; milestones; annual updates to the plan; inclusion of new waste streams; modifications of the plan; funding considerations; low-level mixed waste treatment plan and schedules; and TRU mixed waste streams.

28857 (JAERI-Research–95-019) **Corrosion behavior of a simulated high-level radioactive waste glass under oxic and anoxic conditions.** Maeda, Toshikatsu (Japan Atomic Energy Research Inst., Tokai, Ibaraki (Japan). Tokai Research Establishment); Banba, Tsunetaka; Inagaki, Yaohiro; Furuya, Hirotaka. Japan Atomic Energy Research Inst., Tokyo (Japan). Mar 1995. 24p. (In Japanese). Order Number DE96701323. Source: OSTI; NTIS; INIS.

In a deep geologic repository, atmosphere is reducing (anoxic) due to consumption of oxygen. In the present study, leach tests were conducted under anoxic conditions with a reference of oxic conditions. The anoxic tests were performed in a glove box filled with Ar + 3%H_2. The experimental results show that leach rates of Si, B and alkali elements under anoxic conditions are half those of oxic conditions. A geochemical code PHREEQE was used for analyzing the diffusion and dissolution/precipitation reactions. This analysis suggests that quartz precipitates in anoxic conditions, however cristobalite in oxic conditions. (author).

28858 (JAERI-Research–95-046) **Source term modeling and analysis for vault/trench facilities located in an unsaturated zone.** Munakata, Masahiro (Japan Atomic Energy Research Inst., Tokai, Ibaraki (Japan). Tokai Research Establishment); Kimura, Hideo; Matsuzuru, Hideo. Japan Atomic Energy Research Inst., Tokyo (Japan). Jun 1995. 65p. Order Number DE96701391. Source: OSTI; NTIS; INIS.

This report outlines an analytical work on the third test case, Test Case 2b, specified by the IAEA sponsored co-ordinated research programme on the safety assessment of near-surface radioactive waste disposal facilities (NSARS). Test Case 2b focuses on a source term modeling of a disposal facility in an unsaturated soil layer. This report includes an analytical method used, groundwater flow analyses, a screening approach used, and transport calculations carried out, for two types of facilities: (1) a concrete vault with grout backfill around the waste, and (2) an open trench with soil backfill around the waste. Optional infiltration barrier test cases for two types of facilities are also analyzed. The results of the Test Case 2b are presented in this report, and show that the effectiveness of the concrete vault to reduce the infiltration rate to the facilities. Furthermore, in order to examine the suitability of an assumption that a soil layer is saturated, which is often used in safety analyses to avoid a complexity of analyzing an unsaturated-saturated groundwater flow, various conceptual models are applied for the evaluation of the source term. The results show that the assumption of the saturated condition does not always give enough conservative results and then it is important to simulate the unsaturated flow velocity. (author).

28859 (K/WM–96) **Pollution prevention opportunity assessment for the K-25 Site Toxic Substances Control Act Incinerator Operations, Level III.** Oak Ridge K-25 Site, TN (United States); PAI Corp., Oak Ridge, TN (United States). Sep 1995. 150p. Sponsored by USDOE, Washington, DC (United States). DOE Contract AC05-84OR21400. Order Number DE96000422. Source: OSTI; NTIS; INIS; GPO Dep.

Waste Management Program.

A Level III pollution prevention opportunity assessment (PPOA) was performed for the Oak Ridge K-25 Site Toxic Substances Control Act (TSCA) Incinerator to evaluate pollution prevention (P2) options for various waste streams: The main objective of this study was to identify and evaluate options to reduce the quantities of each waste stream generated by the TSCA Incinerator operations to realize significant environmental and/or economic benefits from P2. For each of the waste streams, P2 options were evaluated following the US Environmental Protection Agency (EPA) hierarchy to (1) reduce the quantity of waste generated, (2) recycle the waste, and/or (3) use alternate waste treatment or segregation methods. This report provides process descriptions, identification and evaluation of P2 options, and final recommendations.

28860 (LA–13000) **Effects of soluble organic complexants and their degradation products on the removal of selected radionuclides from high-level waste. Part 3, Distributions of Sr, Cs, Tc, Pu, and Am onto 33 absorbers from four variations of a 3:1 dilution of Hanford complexant concentrate (CC) simulant: Part 4, The effects of varying dilution ratios on the distributions of Sr, Cs, Tc, Pu, and Am onto 12 absorbers.** Marsh, S.F. (Sandia National Labs., Albuquerque, NM (United States)); Svitra, Z.V.; Bowen, S.M. Los Alamos National Lab., NM (United States). Sep 1995. 64p. Sponsored by USDOE, Washington, DC (United States). DOE Contract W-7405-ENG-36. Order Number DE96000291. Source: OSTI; NTIS; INIS; GPO Dep.

Many of the radioactive waste storage tanks at USDOE facilities contain organic compounds that have been degraded by radiolysis and chemical reactions during decades of storage. Objective of this study was to measure effects of soluble organic complexants and their degradation products on sorption of Sr, Cs, Tc, Pu and Am onto 33 absorbers that in the absence of these organic compounds offer high sorption of these elements. The elements were in a generic simulant for Hanford complexant concentrate supernate that initially contained six organic complexants: EDTA, HEDTA, NTA, citrate, gluconate, and iminodiacetate. This simulant was tested as prepared and after gamma-irradiation to approximately 34 Mrads. Two other variations consisted of the unirradiated and irradiated simulants after treatment at 450C and 15,000 psi in a hydrothermal organic-destruction process. These experiments were conducted with a 3:1 water-to-simulant dilution of each of the four simulant variations. To determine effects of varying dilution ratios on the sorption of these five elements from the unirradiated and gamma-irradiated simulants that were not treated with the hydrothermal process, we measured their distribution from a 1:1 dilution, using 1 M NaOH as the diluent, onto the 12 best-performing absorbers. We then measured the sorption of these five elements from solutions having diluent-simulant ratios of 0, 0.5, 2.0, and 3.0 onto the three absorbers that performed best for sorbing Sr, Pu and Am from the 1:1 dilution. For each of 900 element/absorber/solution combinations, we measured distribution coefficients (Kd values) twice for each period for dynamic contact periods of 30 min, 2 h, and 6 h to obtain information about absorber stability and sorption kinetics. The 5400 measured Kd values indicate that the sorption of Sr, Pu, and Am is significantly decreased by the organic complexants in these simulant solutions, whereas the sorption of Cs and Tc is much less affected.

28861 (LA–13041-MS) **Mixed waste treatment model: Basis and analysis.** Palmer, B.A. Los Alamos National Lab., NM (United States). Sep 1995. 60p. Sponsored by USDOE, Washington, DC (United States). DOE Contract W-7405-ENG-36. Order Number DE96000887. Source: OSTI; NTIS; INIS; GPO Dep.

The Department of Energy's Programmatic Environmental Impact Statement (PEIS) required treatment system capacities for risk and cost calculation. Los Alamos was tasked with providing these capacities to the PEIS team. This involved understanding the Department of Energy (DOE) Complex waste, making the necessary changes to correct for problems, categorizing the waste for treatment, and determining the treatment system requirements. The treatment system requirements depended on the incoming waste, which varied for each PEIS case. The treatment system requirements also depended on the type of treatment that was desired. Because different groups contributing to the PEIS needed specific types of results, we provided the treatment system requirements in a variety of forms. In total, some 40 data files were created for the TRU cases, and for the MLLW case, there were 105 separate data files. Each data file represents one treatment case consisting of the selected waste from various sites, a selected treatment system, and the reporting requirements for such a case. The treatment system requirements in their most basic form are the treatment process rates for unit operations in the desired treatment system, based on a 10-year working life and 20-year accumulation of the waste. These results were reported in cubic meters and for the MLLW case, in kilograms as well. The treatment system model consisted of unit operations that are linked together. Each unit operation's function depended on the input waste streams, waste matrix, and contaminants. Each unit operation outputs one or more waste streams whose matrix, contaminants, and volume/mass may have changed as a result of the treatment. These output streams are then routed to the appropriate unit operation for additional treatment until the output waste stream meets the treatment requirements for disposal. The total waste for each unit operation was calculated as well as the waste for each matrix treated by the unit.

28862 (LA-SUB–95-167) **Advanced manufacturing technology task. Final report, February–September 1990.** Los Alamos National Lab., NM (United States); Quatro Corp., Albuquerque, NM (United States). [1990]. 4p. Sponsored by USDOE, Washington, DC (United States). DOE Contract W-7405-ENG-36. Order Number DE96000859. Source: OSTI; NTIS (US Sales Only); GPO Dep.

During March, the Advanced Manufacturing initiative was refocused on the depleted uranium waste recovery program. This is an effort to apply the plasma torch technology developed by the laboratory, to the recovery of waste produced by the DoD programs which use depleted uranium for penetrating warheads. The need for new technology arises from the high cost of disposing of the manufacturing waste. Quatro met with technical staff from DIO, MEE Division and MST Division to develop a general approach. Quatro took responsibility for defining the potential demand for waste processing. Quatro contacted the relevant Army and Navy Program representatives to obtain projections of future demand. In addition, contact was made with several manufacturing companies and with private consultants. The assembled data was presented in a set of viewgraphs for internal Los Alamos review.

28863 (LA-UR–95-3103) **Operating new 55-gallon drum shufflers at Los Alamos.** Hsue, F.; Hurd, J.R.; Rinard, P.M. Los Alamos National Lab., NM (United States). [1995]. 7p. Sponsored

by USDOE, Washington, DC (United States). DOE Contract W-7405-ENG-36. (CONF-950923–3: 5. international conference on facility-safeguards interface, Jackson Hole, WY (United States), 24-30 Sep 1995). Order Number DE96000046. Source: OSTI; NTIS; INIS; GPO Dep.

Two passive-active shufflers for the assay of uranium and plutonium have begun operation at Los Alamos National Laboratory. An extensive period of safety and technology assessments were made to meet laboratory and DOE certification requirements. Many design features of the shufflers are in place to assist the operator in using the instruments efficiently, effectively, and safely. A calibration for uranium oxide has been completed and applied to a variety of uranium-bearing inventory materials. A new calibration for MOX materials is nearly complete and additional uranium and plutonium materials will be measured in the near future.

28864 (LA-UR–95-17922, pp. 8-21) **Potential benefits of waste transmutation to the U.S. high-level waste respository.** Michaels, G.E. (Oak Ridge National Laboratory, TN (United States)). Los Alamos National Lab., NM (United States). [1995]. (CONF-9407103–: International conference on accelerator-driven transmutation technologies and applications, Las Vegas, NV (United States), 25 Jul - 1 aug 1994). In *AIP conference on accelerator driven transmutation technologies and applications, Los Vegas, Nevada, July 25-29, 1994.* 958p. Order Number DE95014018. Source: OSTI; NTIS; INIS.

This paper reexamines the potential benefits of waste transmutation to the proposed U.S. geologic repository at the Yucca Mountain site based on recent progress in the performance assessment for the Yucca Mountain base case of spent fuel emplacement. It is observed that actinides are assumed to have higher solubility than in previous studies and that Np and other actinides now dominate the projected aqueous releases from a Yucca Mountain repository. Actinides are also indentified as the dominant source of decay heat in the repository, and the effect of decay heat in perturbing the hydrology, geochemistry, and thermal characteristics of Yucca Mountain are reviewed. It is concluded that the potential for thermally-driven, buoyant, gas-phase flow at Yucca Mountain introduces data and modeling requirements that will increase the costs of licensing the site and may cause the site to be unattractive for geologic disposal of wastes. A transmutation-enabled cold repository is proposed that might allow licensing of a repository to be based upon currently observable characteristics of the Yucca Mountain site.

28865 (LA-UR–95-17922, pp. 44-53) **A high gain energy amplifier operated with fast neutrons.** Rubbia, C. (CERN, Geneva (Switzerland)). Los Alamos National Lab., NM (United States). [1995]. (CONF-9407103–: International conference on accelerator-driven transmutation technologies and applications, Las Vegas, NV (United States), 25 Jul - 1 aug 1994). In *AIP conference on accelerator driven transmutation technologies and applications, Los Vegas, Nevada, July 25-29, 1994.* 958p. Order Number DE95014018. Source: OSTI; NTIS; INIS.

The basic concept and the main practical considerations of an Energy Amplifier (EA) have been exhaustively described elsewhere. Here the concept of the EA is further explored and additional schemes are described which offer a higher gain, a larger maximum power density and an extended burn-up. All these benefits stem from the use of fast neutrons, instead of thermal or epithermal ones, which was the case in the original study. The higher gain is due both to a more efficient high energy target configuration and to a larger, practical value of the multiplication factor. The higher power density results from the higher permissible neutron flux, which in turn is related to the reduced rate of ^{233}Pa neutron captures (which, as is well known, suppress the formation of the fissile ^{233}U fuel) and the much smaller k variations after switch-off due to ^{233}Pa decays for a given burn-up rate. Finally a longer integrated burn-up is made possible by reduced capture rate by fission fragments of fast neutrons. In practice a 20 MW proton beam (20 mA @ 1 GeV) accelerated by a cyclotron will suffice to operate a compact EA at the level of $\approx$ 1 GW_e. The integrated fuel burn-up can be extended in excess of 100 GW d/ton, limited by the mechanical survival of the fuel elements. Radio-Toxicity accumulated at the end of the cycle is found to be largely inferior to the one of an ordinary Reactor for the same energy produced. Schemes are proposed which make a "melt-down" virtually impossible. The conversion ratio, namely the rate of production of ^{233}U relative to consumption is generally larger than unity, which permits production of fuel for other uses. Alternatively the neutron excess can be used to transform unwanted "ashes" into more acceptable elements.

28866 (LA-UR–95-17922, pp. 54-63) **Transmutation studies at CEA in frame of the SPIN program objectives, results and future trends.** Salvatores, M. (Commissariat a l'Energie Atomique, Cadarache (France)); Prunier, C.; Guerin, Y. Los Alamos National Lab., NM (United States). [1995]. (CONF-9407103–: International conference on accelerator-driven transmutation technologies and applications, Las Vegas, NV (United States), 25 Jul - 1 aug 1994). In *AIP conference on accelerator driven transmutation technologies and applications, Los Vegas, Nevada, July 25-29, 1994.* 958p. Order Number DE95014018. Source: OSTI; NTIS; INIS.

In order to respond to the public concern about wastes and in particular the long-lived high level ones, a French law issued on December 30, 1991 identified the major objectives of research for the next fifteen years, before a new debate and possibly a decision on final wastes disposal in Parliament. These objectives are: (1) improvement of the wastes conditioning; (2) extraction and transmutation of the long-lived wastes in order to minimize their long term toxicity; (3) research performed in underground laboratories in order to characterize the capacity of geological structures to confine radioactive wastes (two sites have to be selected for these underground laboratories, in concertation with the local population); (4) last, the study of conditioning and prolonged surface storage of wastes.

28867 (LA-UR–95-17922, pp. 64-73) **JAERI R & D on accelerator-based transmutation under OMEGA program.** Takizuka, T. (Japan Atomic Energy Research Institute, Ibaraki-ken (Japan)); Nishida, T.; Mizumoto, M. Los Alamos National Lab., NM (United States). [1995]. (CONF-9407103–: International conference on accelerator-driven transmutation technologies and applications, Las Vegas, NV (United States), 25 Jul - 1 aug 1994). In *AIP conference on accelerator driven transmutation technologies and applications, Los Vegas, Nevada, July 25-29, 1994.* 958p. Order Number DE95014018. Source: OSTI; NTIS; INIS.

The overview of the Japanese long-term research and development program on nuclide partitioning and transmutation, called "OMEGA," is presented. Under this national program, major R&D activities are being carried out at JAERI, PNC, and CRIEPI. Accelerator-based transmutation study at JAERI is focused on a dedicated transmutor with a subcritical actinide-fueled subcritical core coupled with a spallation target driven by a high intensity proton accelerator. Two types of system concept, solid system and molten-salt system, are discussed. The solid system consists of sodium-cooled tungsten target and metallic actinide fuel. The molten-salt system is fueled with molten actinide chloride that acts also as a target material. The proposed plant transmutes about 250 kg of minor actinide per year, and generates enough electricity to power its own accelerator. JAERI is proposing the development of an intense proton linear accelerator ETA with 1.5 GeV-10 mA beam for engineering tests of accelerator-based transmutation. Recent achievements in the accelerator development are described.

28868 (LA-UR–95-17922, pp. 83-92) **Development of advanced technological systems for accelerator transmutation.** Batskikh, G.I. (Russian Academy of Sciences, Moscow (Russian Federation)); Bondarev, B.I.; Durkin, A.P. Los Alamos National Lab., NM (United States). [1995]. (CONF-9407103–: International conference on accelerator-driven transmutation technologies and applications, Las Vegas, NV (United States), 25 Jul - 1 aug 1994). In *AIP conference on accelerator driven transmutation technologies and applications, Los Vegas, Nevada, July 25-29, 1994.* 958p. Order Number DE95014018. Source: OSTI; NTIS; INIS.

A development concept of the accelerator nuclear energy reactors is considered for energy generation and nuclear power plant waste conversion into short-lived nuclides along with the requirements imposed on the technological systems necessary for implementation of such projects. The state of art in the field is discussed.

28869 (LA-UR–95-17922, pp. 93-104) **Introduction to spallation physics and spallation-target design.** Russell, G.J. (Los Alamos National Laboratory, NM (United States)); Pitcher, E.J.; Daemen, L.L. Los Alamos National Lab., NM (United States). [1995]. (CONF-9407103–: International conference on accelerator-driven transmutation technologies and applications, Las Vegas, NV (United States), 25 Jul - 1 aug 1994). In *AIP conference on accelerator driven transmutation technologies and applications, Los Vegas, Nevada, July 25-29, 1994.* 958p. Order Number DE95014018. Source: OSTI; NTIS; INIS.

When coupled with the spallation process in appropriate target materials, high-power accelerators can be used to produce large numbers of neutrons, thus providing an alternate method to the use of nuclear reactors for this purpose. Spallation offers exciting new possibilities for generating intense neutron fluxes for a variety of applications, including: (a) spallation-neutron sources for materials science research; (b) accelerator-based production of tritium; (c) accelerator-based transmutation of waste; (d) accelerator-based destruction of plutonium; and (e) radioisotope production for medical and energy applications. Target design plays a key role in these applications, with neutron production/leakage being strongly dependent on the incident particle type and energy, and target material and geometry.

28870 (LA-UR–95-17922, pp. 105-115) **A target development program for beamhole spallation neutron sources in the megawatt range.** Bauer, G.S. (Rutherford Appleton Laboratory, Oxon (United Kingdom)); Atchison, F. Los Alamos National Lab., NM (United States). [1995]. (CONF-9407103–: International conference on accelerator-driven transmutation technologies and applications, Las Vegas, NV (United States), 25 Jul - 1 aug 1994). In *AIP conference on accelerator driven transmutation technologies and applications, Los Vegas, Nevada, July 25-29, 1994.* 958p. Order Number DE95014018. Source: OSTI; NTIS; INIS.

Spallation sources as an alternative to fission neutron sources have been operating successfully up to 160 kW of beam power. With the next generation of these facilities aiming at the medium power range between 0.5 and 5 MW, loads on the targets will be high enough to make present experience of little relevance. With the 0.6 MW continuous facility SINQ under construction, and a 5 MW pulsed facility (ESS) under study in Europe, a research and development program is about to be started which aimes at assessing the limits of stationary and moving solid targets and the feasibility and potential benefits of flowing liquid metal targets. Apart from theoretical work and examination of existing irradiated material, including used targets from ISIS, it is intended to take advantage of the SINQ solid rod target design to improve the relevant data base by building the target in such a way that individual rods can be equipped as irradiation capsules.

28871 (LA-UR–95-17922, pp. 116-136) **The physics design of accelerator-driven transmutation systems.** Venneri, F. (Los Alamos National Laboratory, NM (United States)). Los Alamos National Lab., NM (United States). [1995]. (CONF-9407103–: International conference on accelerator-driven transmutation technologies and applications, Las Vegas, NV (United States), 25 Jul - 1 aug 1994). In *AIP conference on accelerator driven transmutation technologies and applications, Los Vegas, Nevada, July 25-29, 1994.* 958p. Order Number DE95014018. Source: OSTI; NTIS; INIS.

Nuclear systems under study in the Los Alamos Accelerator-Driven Transmutation Technology program (ADTT) will allow the destruction of nuclear spent fuel and weapons-return plutonium, as well as the production of nuclear energy from the thorium cycle, without a long-lived radioactive waste stream. The subcritical systems proposed represent a radical departure from traditional nuclear concepts (reactors), yet the actual implementation of ADTT systems is based on modest extrapolations of existing technology. These systems strive to keep the best that the nuclear technology has developed over the years, within a sensible conservative design envelope and eventually manage to offer a safe, less expensive and more environmentally sound approach to nuclear power.

28872 (LA-UR–95-17922, pp. 235-246) **Potential role of ABC-assisted repositories in U.S. plutonium and high-level waste disposition.** Berwald, D. (Grumman Aerospace Corporation, Bethpage, NY (United States)); Favale, A.; Myers, T. Los Alamos National Lab., NM (United States). [1995]. (CONF-9407103–: International conference on accelerator-driven transmutation technologies and applications, Las Vegas, NV (United States), 25 Jul - 1 aug 1994). In *AIP conference on accelerator driven transmutation technologies and applications, Los Vegas, Nevada, July 25-29, 1994.* 958p. Order Number DE95014018. Source: OSTI; NTIS; INIS.

This paper characterizes the issues involving deep geologic disposal of LWR spent fuel rods, then presents results of an investigation to quantify the potential role of Accelerator-Based Conversion (ABC) in an integrated national nuclear materials and high level waste disposition strategy. The investigation used the deep geological repository envisioned for Yucca Mt., Nevada as a baseline and considered complementary roles for integrated ABC transmutation systems. The results indicate that although a U.S. geologic waste repository will continue to be required, waste partitioning and accelerator transmutation of plutonium, the minor actinides, and selected long-lived fission products can result in the following substantial benefits: plutonium burndown to near zero levels, a dramatic reduction of the long term hazard associated with geologic repositories, an ability to place several-fold more high level nuclear waste in a single repository, electricity sales to compensate for capital and operating costs.

28873 (LA-UR–95-17922, pp. 248-254) **Waste transmutation with minimal fuel cycle long-term risk.** Slessarev, I. (Direction des Reacteurs Nucleaires, Cadarache (France)); Salvatores, M.; Uematsu, M. Los Alamos National Lab., NM (United States). [1995]. (CONF-9407103–: International conference on accelerator-driven transmutation technologies and applications, Las Vegas, NV (United States), 25 Jul - 1 aug 1994). In *AIP conference on accelerator driven transmutation technologies and applications, Los Vegas, Nevada, July 25-29, 1994.* 958p. Order Number DE95014018. Source: OSTI; NTIS; INIS.

Hybrid systems (source-driven subcritical reactors), are investigated at CEA, mainly from a conceptual point of view, in order to assess their potential to transmute radioactive wastes (mainly long-lived fission products, LLFP) and their potential to insure a minimal long-term radiological risk related both to the fuel inventory inside the system and to the full fuel cycle (mass flows, reprocessing transport, waste disposal). The physics of these systems has been explored and work is in progress both in the field of basic data and INC code validation, in the frame of international collaborations and in the field of conceptual design studies. The most interesting feature of subcritical source-driven system is related to the possibility to obtain an "excess" of neutrons per fission, which can be used to reduce the long-term radiological risk. A specific example will be discussed here.

28874 (LA-UR–95-17922, pp. 255-263) **An overview of Russian experience and capabilities for development of ATW/ABC systems.** Kazaritsky, V.D. (Institute for Theoretical and Experimental Physics, Moscow (Russian Federation)). Los Alamos National Lab., NM (United States). [1995]. (CONF-9407103–: International conference on accelerator-driven transmutation technologies and applications, Las Vegas, NV (United States), 25 Jul - 1 aug 1994). In *AIP conference on accelerator driven transmutation technologies and applications, Los Vegas, Nevada, July 25-29, 1994.* 958p. Order Number DE95014018. Source: OSTI; NTIS; INIS.

Several Russian institutes are expected to undertake a feasibility study of nuclear power systems based on proton accelerators. The examined systems are intended for conversion of surplus Pu and transmutation of long-lived radioactive waste. This research motivated by the demilitarisation agreements and criticism of traditional nuclear power is focused on environmental protection.

28875 (LA-UR–95-17922, pp. 264-267) **On the ATW-concepts: ITP approach and opportunities.** Simonenko, V.A. (Institute of Technical Physics, Chelyabinsk (Russian Federation)); Gregyonkin, K.F. Los Alamos National Lab., NM (United States). [1995]. (CONF-9407103–: International conference on accelerator-driven transmutation technologies and applications, Las Vegas, NV (United States), 25 Jul - 1 aug 1994). In *AIP conference on accelerator driven transmutation technologies and applications, Los*

Vegas, Nevada, July 25-29, 1994. 958p. Order Number DE95014018. Source: OSTI; NTIS; INIS.

It is discussed the interest of Russian Federal Nuclear Center - Institute of Technical Physics at Chelyabinsk-70 in the research of Accelerator Driven Technologies applications for radioactive waste transmutation, cumulated actinides burning, energy production. The ITP background and opportunities for this research are presented. It is shown the ITP possibilities for testing and experimental development of Accelerator Driven Technologies.

28876 (LA-UR–95-17922, pp. 268-273) **Accelerator-driven nuclear synergetic systems-an overview of the research activities in Sweden.** Conde, H. (Uppsala Univ. (Sweden)); Baecklin, A.; Carius, S. Los Alamos National Lab., NM (United States). [1995]. (CONF-9407103–: International conference on accelerator-driven transmutation technologies and applications, Las Vegas, NV (United States), 25 Jul - 1 aug 1994). In *AIP conference on accelerator driven transmutation technologies and applications, Los Vegas, Nevada, July 25-29, 1994.* 958p. Order Number DE95014018. Source: OSTI; NTIS; INIS.

The rapid development of the accelerator technology which enables the construction of reliable and very intense neutron sources has initiated a growing interest for accelerator driven transmutation systems in Sweden. After the Specialist Meeting on Accelerator-Driven Transmutation Technology for Radwaste and other Applications on 24-28 June 1991 at Saltsjoebaden, Sweden, the research activities oriented towards accelerator-driven systems have been started at several research centers in Sweden. Also the governmental agencies responsible for the spent fuel policy showed a positive attitude to these activities through a limited financial support, particularly for studies of the safety aspects of these systems. Also the nuclear power industry and utilities show a positive interest in the research on these concepts. The present paper presents an overview of the Swedish research activities on accelerator-driven systems and the proposed future coordination, organizations and prospects for this research in the context of the national nuclear energy and spent fuel policy. The Swedish perspective for international cooperation is also described.

28877 (LA-UR–95-17922, pp. 274-280) **Specific contributions of the Dutch programme "RAS" towards accelerator-based transmutation.** Abrahams, K. (Netherlands Energy Research Foundation (ECN), Petten (Netherlands)); Franken, W.M.P.; Bultman, J.H. Los Alamos National Lab., NM (United States). [1995]. (CONF-9407103–: International conference on accelerator-driven transmutation technologies and applications, Las Vegas, NV (United States), 25 Jul - 1 aug 1994). In *AIP conference on accelerator driven transmutation technologies and applications, Los Vegas, Nevada, July 25-29, 1994.* 958p. Order Number DE95014018. Source: OSTI; NTIS; INIS.

Accelerator-based transmutation is being studied by ECN within its general nuclear waste transmutation programme RAS. In this paper the following contributions are presented: (1) Evaluation of cross sections at intermediate energies, within an international frame given by NEA, (2) Cell calculations on the equilibration of transuranium actinides in thermal molten-salt transmuters, (3) Irradiation facilities at the European research reactor HFR in Petten, which have been constructed with the purpose to demonstrate and investigate the transmutation of waste in a high neutron flux, (4) Studies of accelerator-based neutron generating systems to transmute neptunium and technetium, (5) Comparison of several systems on the basis of criteria for successful nuclear waste-management.

28878 (LA-UR–95-17922, pp. 281-288) **Site layout and balance of plant design for an accelerator-driven materials processing complex.** Cunliffe, J. (Bechtel Corporation, San Francisco, CA (United States)); Taussig, R.; Ghose, S. Los Alamos National Lab., NM (United States). [1995]. (CONF-9407103–: International conference on accelerator-driven transmutation technologies and applications, Las Vegas, NV (United States), 25 Jul - 1 aug 1994). In *AIP conference on accelerator driven transmutation technologies and applications, Los Vegas, Nevada, July 25-29, 1994.* 958p. Order Number DE95014018. Source: OSTI; NTIS; INIS.

High energy proton beam accelerators are under consideration for use in radioisotope production, surplus weapons material destruction, radioactive waste transmutation, and thorium-based energy conversion cycles. While there are unique aspects to each of these applications that must be accommodated in the design of the associated facility, all share a set of fundamental characteristics that in large measure dictate the site layout features and many balance-of-plant (BOP) design requirements found to be common to all. This paper defines these key design determinants and goes on to discuss the manner in which they have been accommodated in the pre-conceptual design for a particular materials production application. An estimate of the costs associated with this BOP design is also presented with the aim of guiding future evaluations where the basic plant designs are similar to that of this specific case.

28879 (LA-UR–95-17922, pp. 289-298) **Simulation of radioactive waste transmutation on the t.node parallel computer.** Bacha, F. (LPC College de France, Paris (France)); Maillard, J.; Silva, J. Los Alamos National Lab., NM (United States). [1995]. (CONF-9407103–: International conference on accelerator-driven transmutation technologies and applications, Las Vegas, NV (United States), 25 Jul - 1 aug 1994). In *AIP conference on accelerator driven transmutation technologies and applications, Los Vegas, Nevada, July 25-29, 1994.* 958p. Order Number DE95014018. Source: OSTI; NTIS; INIS.

Before any experiment on reactor driven by an accelerator, computer simulation supplies tools for optimization. Some of the key parameters are neutron production on a heavy target and neutronic distribution flux in the core. During two code benchmarks organized by the NEA-OECD, simulations of energetic incident proton collisions on a thin lead target for the first one, on a thick lead target for the second one, are described. One validation of the numeric codes is based on these results. A preliminary design of a burning waste system using benchmark result analysis and fission focused simulations is proposed.

28880 (LA-UR–95-17922, pp. 299-306) **Accelerator driven reactors and nuclear waste management projects in the Czech Republic.** Janouch, F. (Royal Institute of Technology, Stockholm (Sweden)); Mach, R. Los Alamos National Lab., NM (United States). [1995]. (CONF-9407103–: International conference on accelerator-driven transmutation technologies and applications, Las Vegas, NV (United States), 25 Jul - 1 aug 1994). In *AIP conference on accelerator driven transmutation technologies and applications, Los Vegas, Nevada, July 25-29, 1994.* 958p. Order Number DE95014018. Source: OSTI; NTIS; INIS.

The Czech Republic is almost the only country in the central Europe which continues with the construction of nuclear power reactors. Its small territory and dense population causes public worries concerning the disposal of the spent nuclear fuel. The Czech nuclear scientists and the power companies and the nuclear industries are therefore looking for alternative solutions. The Los Alamos ATW project had received a positive response in the Czech mass-media and even in the industrial and governmental quarters. The recent scientific symposium "Accelerator driven reactors and nuclear waste management" convened at the Liblice castle near Prague, 27-29. 6. 1994 and sponsored by the Czech Energy Company CEZ, reviewed the competencies and experimental basis in the Czech republic and made the first attempt to formulate the national approach and to establish international collaboration in this area.

28881 (LA-UR–95-17922, pp. 307-313) **Benefits and risks of P & T of nuclear waste.** Abrahams, K. (Netherlands Energy Research Foundation, Petten (Netherlands)). Los Alamos National Lab., NM (United States). [1995]. (CONF-9407103–: International conference on accelerator-driven transmutation technologies and applications, Las Vegas, NV (United States), 25 Jul - 1 aug 1994). In *AIP conference on accelerator driven transmutation technologies and applications, Los Vegas, Nevada, July 25-29, 1994.* 958p. Order Number DE95014018. Source: OSTI; NTIS; INIS.

Efforts on waste transmutation are coordinated in a research programme called RAS. One of the aims of this RAS program is to inform the public and advise the authorities on methods for transmutation/conditioning of nuclear waste, and on techniques which are being developed. Such new procedures for the treatment of

waste should of course not lead to significant risks for the present population. Small risks might be accepted, but these should sufficiently be compensated for by favours to future generations.

28882 (LA-UR–95-17922, pp. 324-330) **EURAC: A liquid target neutron spallation.** Perlado, J.M. (Universidad Politecnica de Madrid (Spain)); Minguez, E.; Sanz, J. Los Alamos National Lab., NM (United States). [1995]. (CONF-9407103–: International conference on accelerator-driven transmutation technologies and applications, Las Vegas, NV (United States), 25 Jul - 1 aug 1994). In *AIP conference on accelerator driven transmutation technologies and applications, Los Vegas, Nevada, July 25-29, 1994.* 958p. Order Number DE95014018. Source: OSTI; NTIS; INIS.

Euratom/JRC Ispra led some years ago the design of an accelerator based neutron spallation source EURAC, with special emphasis as a fusion material testing device. DENIM was involved in the development of the last version of this source. EURAC proposes to use a beam of 600 MeV or 1.5 GeV protons, produced by an effective and low cost ring cyclotron with a current of 6 mA impinging in a liquid lead, or lead-bismuth, target. It will use an advanced cyclotron technology which can be implemented in the next future, in the line of the actual technology of the upgraded SIN-type cyclotron. The adjacent rows to the target correspond to the lead, or $Li_{17}Pb_{83}$, cooled channels where the samples will be located. The available volumes there were shown enough for material testing purposes. Here, proposal of using those experimental areas to introduce small masses of radioactive wastes for testing of transmutation in spaliation source is made. In addition, extrapolation of present conceptual design to make available larger volumes under flexible conditions seems to be possible. Neutrons leaking from the test zone drive a subcritical booster (<10 MW) which could provide a thermal neutron flux trap with a liquid hydrogen moderator in the center.

28883 (LA-UR–95-17922, pp. 518-524) **Direct irradiation of long-lived fission products in an ATW system.** Carter, T.F. (Univ. of Tennessee, Knoxville, TN (United States)); Henderson, D.; Sailor, W.C. Los Alamos National Lab., NM (United States). [1995]. (CONF-9407103–: International conference on accelerator-driven transmutation technologies and applications, Las Vegas, NV (United States), 25 Jul - 1 aug 1994). In *AIP conference on accelerator driven transmutation technologies and applications, Los Vegas, Nevada, July 25-29, 1994.* 958p. Order Number DE95014018. Source: OSTI; NTIS; INIS.

The feasibility of directly irradiating five long-lived fission products (LLFPs: ^{79}Se, ^{93}Zr, ^{107}Pd, ^{126}Sn, and ^{135}Cs, each with a half-life greater than 10,000 years), by incorporating them into the target of an Accelerator Transmutation of Waste (ATW) system is discussed. The important parameters used to judge the feasibility of a direct irradiation system were the target's neutron spallation yield (given in neutrons produced per incident proton), and the removal rate of the LLFP, with the baseline incineration rate set at two light water reactors (LWRs) worth of the LLFP waste per year. A target was constructed which consisted of a LLFP cylindrical "plug" inserted into the top (where the proton beam strikes) of a 30 cm radius, 100 cm length lead target. ^{126}Sn and ^{79}Se were each found to have high enough removal rates to support two LWR's production of the LLFP per year of ATW operation. For the baseline plug geometry (5 cm radius, 30 cm length) containing ^{126}Sn, 3.5 LWRs could be supported per year (at 75% beam availability). Furthermore, the addition of a ^{126}Sn plus had a slightly positive effect on the target's neutron yield. The neutron production was 36.83 $\pm$.0039 neutrons per proton with a pure lead target having a yield of 36.29 $\pm$.0038. It was also found that a plug composed of a tin-selenide compound (SnSe) had high enough removal rates to burn two or more reactor years of both LLFPs simultaneously.

28884 (LA-UR–95-17922, pp. 534-540) **Study of the burning capability of the Los Alamos ATW system.** Landeyro, P.A. (ENEA, Roma (Italy)); Buccafurni, A.; Orazi, A. Los Alamos National Lab., NM (United States). [1995]. (CONF-9407103–: International conference on accelerator-driven transmutation technologies and applications, Las Vegas, NV (United States), 25 Jul - 1 aug 1994). In *AIP conference on accelerator driven transmutation technologies and applications, Los Vegas, Nevada, July 25-29, 1994.* 958p. Order Number DE95014018. Source: OSTI; NTIS; INIS.

The aim of calculations is to evaluate the evolution of the infinate multiplication factor (k_{inf}) during the irradiation of minor actinides, High Level Waste (HLWL) and Plutonium. The most important results are independently verified with Monte Carlo calculations. The relative importance of the main parameters affecting the k_{inf} was investigated by performing calculations with several minor actinide and plutonium concentrations as well as different ^{238}U decontamination factors for HLW. The merit figure value for minor actinide alone, considering a constant neutron flux indicates that the best results are reached for minor actinide concentration equal to PWR spent fuel. The best plutonium burning results are obtained for a concentration (50.23 g/l) equal to the half of PWR spent fuel one. The simulations lead to two different reactor concepts: one for HLW burning and the other for plutonium burning purposes. To burn the HLW the most suitable reactor is an homogeneous one. This kind of reactor can effectively be utilised to burn minor actinide in low concentration (namely the PWR spent fuel). On the other hand an heterogeneous reactor with channels filled by all actinides present in PWR spent fuel with the exclusion of U isotopes with a concentration of 50 g/l can be studied.

28885 (LA-UR–95-17922, pp. 626) **Use of pyroprocessing in the preparation of spent fuel for transmutation.** Laidler, J.J. (Argonne National Laboratory, IL (United States)). Los Alamos National Lab., NM (United States). [1995]. (CONF-9407103–: International conference on accelerator-driven transmutation technologies and applications, Las Vegas, NV (United States), 25 Jul - 1 aug 1994). In *AIP conference on accelerator driven transmutation technologies and applications, Los Vegas, Nevada, July 25-29, 1994.* 958p. Order Number DE95014018. Source: OSTI; NTIS; INIS.

Pyrochemical processing, or "pyroprocessing," of spent fuel offers a number of unique advantages, particularly in comparison with coventional aqueous solvent extraction techniques. Pyroprocessing, in its present version, has been under development for nearly ten years. Emphasis has been placed on the development of a simple, efficient process that features compact, inexpensive process equipment. Particular attention has been paid to the minimization of waste volumes and to the development of a process that is both economic and environmentally sound as well as proliferation-resistant.

28886 (LA-UR–95-17922, pp. 645-651) **The extraction of some trivalent elements with Aliquat-336.** FLandgren, A. (Chalmers Univ. of Technology, Goeteborg (Sweden)); Liljenzin, J.O.; Skalberg, M. Los Alamos National Lab., NM (United States). [1995]. (CONF-9407103–: International conference on accelerator-driven transmutation technologies and applications, Las Vegas, NV (United States), 25 Jul - 1 aug 1994). In *AIP conference on accelerator driven transmutation technologies and applications, Los Vegas, Nevada, July 25-29, 1994.* 958p. Order Number DE95014018. Source: OSTI; NTIS; INIS.

The extraction behaviour of some trivalent elements in the Aliquate-336-1,3-diisopropyl genzene-nitric acid system has been investigated. For most of the elements a maximum in the distribution ratio occur at about 2 molar nitric acid. At 0.20 molar Aliquate-336 lanthanum attained the highest distribution ratio, about 0.05, of all investigated elements. It was found that nitric acid to a large extent influences the distribution ratio of trivalent elements since it competes with metal nitrate complexes for the extractant molecules. A first approach to a model describing the extraction system is derived.

28887 (LA-UR–95-17922, pp. 653-661) **Chemico-technological support of transmutation objectives: Solid, molten salt and liquid blanket.** Volk, V.I. (VNIINM, Moscow (Russian Federation)); Zakharkin, B.S.; Vakhrushin, A.Y. Los Alamos National Lab., NM (United States). [1995]. (CONF-9407103–: International conference on accelerator-driven transmutation technologies and applications, Las Vegas, NV (United States), 25 Jul - 1 aug 1994). In *AIP conference on accelerator driven transmutation technologies and applications, Los Vegas, Nevada, July 25-29, 1994.* 958p. Order Number DE95014018. Source: OSTI; NTIS; INIS.

Chemical and technological provision for the transmutation process, independantly on the scheme of its conduction, includes: fuel composition separation for fractions of components, subjected to annihilation; their transition into chemical form, in which they are present in the reactor; discharge and return into the form, convenient for chemical reprocessing, providing for the transmutation products separation from the components being transmutated and transferring of short-lived isotopes into the form of their temporary storage. The authors discuss different chemical processes which can be used in these steps to either improve efficiency or minimize additional waste generation and expense associated with decontamination. They consider processes involving molten salts for circulation of wastes thru transmutation steps, and possible advantages in extraction processes.

28888 (LA-UR–95-17922, pp. 904) **Accelerator driven transmutation technologies conference wrap-up.** Favale, A.J. (Grumman Aerospace Corporation, Las Vegas, NV (United States)). Los Alamos National Lab., NM (United States). [1995]. (CONF-9407103–: International conference on accelerator-driven transmutation technologies and applications, Las Vegas, NV (United States), 25 Jul - 1 aug 1994). In *AIP conference on accelerator driven transmutation technologies and applications, Los Vegas, Nevada, July 25-29, 1994.* 958p. Order Number DE95014018. Source: OSTI; NTIS; INIS.

This presentation is the viewgraphs used by the author to summarize the highlights of the presentations made at the conference. No article was available for this presentation. The author highlights what he felt were the major highlights of this conference. He looks at the conference in terms of five major areas which he encompases in terms of general questions: why are they needed?; what technologies are involved?; what countries have shown interest?; what are the issues?; and what are the underlying drivers?

28889 (LA-UR–95-17922, pp. 906) **Future directions for ADTT concepts.** Miliekowski, C. (Scandatronix Corporation, Las Vegas, NV (United States)). Los Alamos National Lab., NM (United States). [1995]. (CONF-9407103–: International conference on accelerator-driven transmutation technologies and applications, Las Vegas, NV (United States), 25 Jul - 1 aug 1994). In *AIP conference on accelerator driven transmutation technologies and applications, Los Vegas, Nevada, July 25-29, 1994.* 958p. Order Number DE95014018. Source: OSTI; NTIS; INIS.

This presentation is the collection of viewgraphs used by the author to summarize the future for accelerator based systems for transmutation technologies. The author also emphasizes points which need short term effort to provide critical information necessary for modeling, and planning for future work. The author points out how the value of this technology varies depending upon the political and economic factors which are driving the necessity of dealing with radioactive materials. The issues of feasibility, safety, proliferation, cost, and public perception are also addressed.

28890 (LBL–27170(1995)) **1994 Site Environmental Report.** Lawrence Berkeley Lab., CA (United States). May 1995. 350p. Sponsored by USDOE, Washington, DC (United States). DOE Contract AC03-76SF00098. Order Number DE96001003. Source: OSTI; NTIS; INIS; GPO Dep.

The 1994 Site Environmental Report summarizes environmental activities at Lawrence Berkeley Laboratory (LBL) for the calendar year (CY) 1994. The report strives to present environmental data in a manner that characterizes the performance and compliance status of the Laboratory's environmental management programs when measured against regulatory standards and DOE requirements. The report also discusses significant highlight and planning efforts of these programs. The format and content of the report are consistent with the requirements of the US Department of Energy (DOE) Order 5400.1, General Environmental Protection Program.

28891 (LBL–36235) **Flow and transport simulations using T2CG1, a package of conjugate gradient solvers for the TOUGH2 family of codes.** Moridis, G.; Pruess, K. Lawrence Berkeley Lab., CA (United States). Apr 1995. 118p. Sponsored by USDOE, Washington, DC (United States). DOE Contract AC03-76SF00098. Order Number DE96000874. Source: OSTI; NTIS (documentation only); ESTSC (complete software package), P.O. Box 1020, Oak Ridge, TN 37831-1020 (United States); GPO Dep.

This report discusses the details of modifications made to the TOUGH2 family of codes to complement its direct solver which significantly increases the size of problems solved by the TOUGH2 code. With this modification, the TOUGH2 system is being tested in multiphase, multicomponent fluid and heat flow problems related to vadose zone hydrology, nuclear waste disposal, and environmental remediation.

28892 (LBL–36527) **Inverse modeling as a step in the calibration of the LBL-USGS site-scale model of Yucca Mountain.** Finsterle, S.; Bodvarsson, G.S.; Chen, G. Lawrence Berkeley Lab., CA (United States). May 1995. 3p. Sponsored by USDOE, Washington, DC (United States). DOE Contract AC03-76SF00098. (CONF-9504179–4: 6. annual international conference on high level radioactive waste management, Las Vegas, NV (United States), 30 Apr - 5 may 1995). Order Number DE95016455. Source: OSTI; NTIS; INIS; GPO Dep.

Calibration of the LBL-USGS site-scale model of Yucca Mountain is initiated. Inverse modeling techniques are used to match the results of simplified submodels to the observed pressure, saturation, and temperature data. Hydrologic and thermal parameters are determined and compared to the values obtained from laboratory measurements and conventional field test analysis.

28893 (LBL–37200, pp. 1-6) **Analysis of nuclide transport under natural convection and time dependent boundary condition using TOUGH2.** Javeri, V. (Gesellschaft fuer Anlagen- und Reaktorsicherheit (GRS) mbH, Koeln (Germany)). Lawrence Berkeley Lab., CA (United States). Mar 1995. DOE Contract AC03-76SF00098. (CONF-9503110–: TOUGH 95: transport of unsaturated ground water and heat workshop, Berkeley, CA (United States), 20-22 Mar 1995). In *Proceedings of the TOUGH Workshop '95 Lawrence Berkeley Laboratory, Berkeley, California, March 20–22, 1995.* 380p. Order Number DE95014788. Source: OSTI; NTIS; GPO Dep.

After implementation of TOUGH2 at GRS in summer 91, it was first used to analyse the gas transport in a repository for the nuclear waste with negligible heat generation and to verify the results obtained with ECLIPSE/JAV 92/. Since the original version of TOUGH2 does not directly simulate the decay of radionuclide and the time dependent boundary conditions, it is not a appropriate tool to study the nuclide transport in a porous medium/PRU 87, PRU 91/. Hence, in this paper some modifications are proposed to study the nuclide transport under combined influence of natural convection diffusion, dispersion and time dependent boundary condition. Here, a single phase fluid with two liquid components is considered as in equation of state model for water and brine/PRU 91A/.

28894 (LBL–37200, pp. 7-13) **Investigation of potential water inflow into a ventilated tunnel of the proposed low/intermediate-level waste repository in Switzerland.** Eugster, S.M. (Swiss Federal Institute of Technology, Zurich (Switzerland)); Senger, R.K. Lawrence Berkeley Lab., CA (United States). Mar 1995. DOE Contract AC03-76SF00098. (CONF-9503110–: TOUGH 95: transport of unsaturated ground water and heat workshop, Berkeley, CA (United States), 20-22 Mar 1995). In *Proceedings of the TOUGH Workshop '95 Lawrence Berkeley Laboratory, Berkeley, California, March 20–22, 1995.* 380p. Order Number DE95014788. Source: OSTI; NTIS; GPO Dep.

Design calculations of two-phase flow phenomena associated with the construction and ventilation of a tunnel were investigated to estimate the potential water inflow through discrete water-conducting features (WCFs) into the tunnel. The physical processes that were considered in numerical simulations include the transient propagation of the pressure decline into the formation (Valanginian Marl, initially fully saturated, no dissolved gas) as a result of the tunnel construction. Ventilation of the tunnel results in a reduction in relative humidity of the tunnel air which, in turn, causes evaporation of water at the tunnel wall and the potential development of an unsaturated zone into the formation. The objective of this study is to investigate under what conditions the tunnel wall appears wet or dry, i.e. whether WCFs can be identified in a ventilated tunnel by mapping water inflow patterns. The simulation results indicate that inflow to the tunnel decreases with time approaching steady state

flow rates under single-phase flow conditions, which is lower than the evaporation rate. The water inflow rate decreased more rapidly for a first model scenario (WCF parallel to the tunnel axis), caused by linear flow through the WCF, than for a second model scenario (WCF perpendicular to the tunnel axis), characterized by radial flow toward the tunnel. Similarly, the desaturation zone extends farther into the WCF under linear flow than under radial flow.

28895 (LBL–37200, pp. 21) **Drift-scale thermo-hydrologic analyses for the proposed repository at Yucca Mountain, NV.** Reeves, M. (M&O/Intera, Inc., Las Vegas, NV (United States)); Lingineni, S. Lawrence Berkeley Lab., CA (United States). Mar 1995. DOE Contract AC03-76SF00098. (CONF-9503110–: TOUGH 95: transport of unsaturated ground water and heat workshop, Berkeley, CA (United States), 20-22 Mar 1995). In *Proceedings of the TOUGH Workshop '95 Lawrence Berkeley Laboratory, Berkeley, California, March 20–22, 1995.* 380p. Order Number DE95014788. Source: OSTI; NTIS; GPO Dep.

Focusing on the near field of a waste package, this paper presents results obtained from a thermo-hydrologic model. Vertically, the conceptual model extends from ground surface to a depth of 1000 m below the water table. Horizontally, it is bounded by the centerlines of two pillars. Inside an assumed circular drift, an invert (backfill) surrounds the waste package. Here, a coarse-grained crushed tuff is assumed to provide a capillary barrier against infiltrating ground water. For comparison, the invert is replaced by intact tuff, corresponding to borehole emplacement. In further examining the near-field thermo-hydrology of a waste package, the study considers several values of the areal power density together with both nonenhanced and enhanced levels of vapor diffusivity. In order to characterize drift resaturation effects deriving from the latter, the calculations extend to 100,000 years. The clarity of the coding present in LBL's integrated finite-difference model TOUGH2 has permitted us to make several code changes. For the most part, they expedite convergence on difficult applications. The paper briefly discusses these changes.

28896 (LBL–37200, pp. 40-45) **Preliminary analysis of tank 241-C-106 dryout due to large postulated leak and vaporization.** Piepho, M.G. Lawrence Berkeley Lab., CA (United States). Mar 1995. DOE Contract AC03-76SF00098. (CONF-9503110–: TOUGH 95: transport of unsaturated ground water and heat workshop, Berkeley, CA (United States), 20-22 Mar 1995). In *Proceedings of the TOUGH Workshop '95 Lawrence Berkeley Laboratory, Berkeley, California, March 20–22, 1995.* 380p. Order Number DE95014788. Source: OSTI; NTIS; GPO Dep.

At the Hanford site in SE Washington, there are 149 single-shell tanks containing radionuclide wastes in the form of liquids, sludges and salt cakes. One of the tanks, tank 241-C-106, is heated to the boiling point due to radionuclide decay (primarily Sr-90). Water is added to the tank, which is ventilated, in order to cool the tank. This analysis assumes that there is a hypothetical large leak at the bottom of Tank 241-C-106 which initiates the dryout of the tank. The time required for a tank to dryout after a leak is of interest for safety reasons. As a tank dries outs, its temperature is expected to greatly increase, which could affect the structural integrity of the concrete tank dome. Hence, it is of interest to know how fast the temperature in a leaky tank increases, so that mitigation procedures can be planned and implemented in a timely manner. The objective of the study was to determine how long it would take for tank 241-C-106 to reach 350 degrees Fahrenheit (about 177 degrees Centigrade) after a postulated large leak develops at the bottom center of the tank.

28897 (LBL–37200, pp. 52-57) **Requirements on sealing measures due to gas production.** Arens, G.; Hoeglund, L.; Wiborgh, M. Lawrence Berkeley Lab., CA (United States). Mar 1995. DOE Contract AC03-76SF00098. (CONF-9503110–: TOUGH 95: transport of unsaturated ground water and heat workshop, Berkeley, CA (United States), 20-22 Mar 1995). In *Proceedings of the TOUGH Workshop '95 Lawrence Berkeley Laboratory, Berkeley, California, March 20–22, 1995.* 380p. Order Number DE95014788. Source: OSTI; NTIS; GPO Dep.

Since 1981 the former rock salt mine Bartensleben near Morsleben (former GDR) ERAM has been in operation as a repository for low and intermediate level radioactive waste. As a result of the reunification and the changed licensing situation a new closure concept for the repository has to be developed. During the post-operational phase of a repository for radioactive waste gas may be produced by corrosion of metals, microbial degradation and radiolytic decomposition. In the process of developing the concept to be used for backfilling and sealing in ERAM it is important that gas formed in the repository will not disrupt the barrier against radionuclide escape or enhance the radionuclide release. To evaluate the performance and the properties for a bentonite plug as the main element of the sealings gas transport modelling with TOUGH were performed. Due to the lack of site-specific data literature data were used. Consequently, large uncertainties in data remain at present, which were taken into account by a great number of parameter variations. To handle this a course discretisation for the calculations were developed. Started with a two-dimensional grid at the end the calculations were performed with a coarse one-dimensional grid. The primary question to answer in these calculations is if there is a risk for excessive pressurization of the repository caverns as a result of gas generation. In the reference case a maximum pressure of approximately 10 Mpa inside a cavern is reached after 1000 years which seems not to jeopardize the integrity of the repository.

28898 (LBL–37200, pp. 227-332) **Flow reduction due to degassing and redissolution phenomena.** Doughty, C. (Lawrence Berkeley Laboratory, Berkeley, CA (United States)). Lawrence Berkeley Lab., CA (United States). Mar 1995. DOE Contract AC03-76SF00098. (CONF-9503110–: TOUGH 95: transport of unsaturated ground water and heat workshop, Berkeley, CA (United States), 20-22 Mar 1995). In *Proceedings of the TOUGH Workshop '95 Lawrence Berkeley Laboratory, Berkeley, California, March 20–22, 1995.* 380p. Order Number DE95014788. Source: OSTI; NTIS; GPO Dep.

At the Stripa mine in Sweden, flow and transport experiments in a water-saturated fractured granite were conducted to investigate techniques for site characterization for a geologic nuclear waste repository. In the Simulated Drift Experiment, measured water inflow to an excavated drift with pressure held at 1 bar was only 1/9th the value expected based on inflow to boreholes with pressure held at 2.7 bars. Several physical and chemical mechanisms were hypothesized to be responsible for this reduction in flow. One possibility is that significant degassing of dissolved nitrogen takes place between 2.7 and 1 bars, credating a two-phase regime with an accompanying decrease in fluid mobilty, resulting in a decrease in flow to the drift. To investigate this process, theoretical studies on degassing and redissolution phenomena have been carried out, beginning with an idealized model which yields a simple analytical solution, then relaxing some of the simplifying assumptions and using TOUGH2 to study the phenomena numerically. In conjunction with these theoretical studies, laboratory experiments on flow and degassing in transparent fracture replicas are being carried out, and are being used to check the modeling approach. We need to develop a fundamental understanding of degassing and redissolution in particular and two-phase flow phenomena in general for flow in fractures and fracture networks, in order to successfully model conditions around a nuclear waste repository, where long time and large space scales may preclude conclusive field experiments.

28899 (LBL–37200, pp. 335-343) **Application of TOUGH to hydrologic problems related to the unsaturated zone site investigation at Yucca Mountain, Nevada.** Kwicklis, E.M. (Geological Survey, Lakewood, CO (United States)); Healy, R.W.; Bodvarsson, G.S. Lawrence Berkeley Lab., CA (United States). Mar 1995. DOE Contract AC03-76SF00098. (CONF-9503110–: TOUGH 95: transport of unsaturated ground water and heat workshop, Berkeley, CA (United States), 20-22 Mar 1995). In *Proceedings of the TOUGH Workshop '95 Lawrence Berkeley Laboratory, Berkeley, California, March 20–22, 1995.* 380p. Order Number DE95014788. Source: OSTI; NTIS; GPO Dep.

To date, TOUGH and TOUGH2 have been the principal codes used by the U.S. Geological Survey in their investigation of the hydrology of the unsaturated zone at Yucca Mountain. Examples of some applications of the TOUGH and TOUGH2 codes to flow and transport problems related to the Yucca Mountain site investigation are presented, and the slight modifications made to the codes to implement them are discussed. These examples include: (1) The

use of TOUGH in a simple fracture network model, with a discussion of an approach to calculate directional relative permeabilities at computational cells located at fracture intersections. These simulations illustrated that, under unsaturated conditions, the locations of dominant pathways for flow through fracture networks are sensitive to imposed boundary conditions; (2) The application of TOUGH to investigate the possible hydrothermal effects of waste-generated heat at Yucca Mountain using a dual-porosity, dual-permeability treatment to better characterize fracture-matrix interactions. Associated modifications to TOUGH for this application included implementation of a lookup table that can express relative permeabilities parallel and transverse to the fracture plane independently. These simulations support the continued use of an effective media approach in analyses of the hydrologic effects of waste-generated heat; and (3) An investigation of flow and tracer movement beneath a wash at Yucca Mountain in which a particle tracker was used as a post-processor. As part of this study, TOUGH2 was modified to calculate and output the x-,y- and z- sequence of tuffs overlying the potential repository site will result in the formation of capillary barriers that locally promote considerable lateral flow, thereby significantly decreasing the magnitude of fluxes form peak values at the ground surface and delaying the arrival of surface-derived moisture at the potential repository horizon.

28900 (LBL–37492) **Estimation of hydraulic conductivities of Yucca Mountain tuffs from sorptivity and water retention measurements.** Zimmerman, R.W.; Bodvarsson, G.S. Lawrence Berkeley Lab., CA (United States). Jun 1995. 31p. Sponsored by USDOE, Washington, DC (United States). DOE Contract AC03-76SF00098. Order Number DE96001002. Source: OSTI; NTIS; INIS; GPO Dep.

The hydraulic conductivity functions of the matrix rocks at Yucca Mountain, Nevada, are among the most important data needed as input for the site-scale hydrological model of the unsaturated zone. The difficult and time-consuming nature of hydraulic conductivity measurements renders it infeasible to directly measure this property on large numbers of cores. Water retention and sorptivity measurements, however, can be made relatively rapidly. The sorptivity is, in principle, a unique functional of the conductivity and water retention functions. It therefore should be possible to invert sorptivity and water retention measurements in order to estimate the conductivity; the porosity is the only other parameter that is required for this inversion. In this report two methods of carrying out this inversion are presented, and are tested against a limited data set that has been collected by Flint et al. at the USGS on a set of Yucca Mountain tuffs. The absolute permeability is usually predicted by both methods to within an average error of about 0.5 - 1.0 orders of magnitude. The discrepancy appears to be due to the fact that the water retention curves have only been measured during drainage, whereas the imbibition water retention curve is the one that is relevant to sorptivity measurements. Although the inversion methods also yield predictions of the relative permeability function, there are yet no unsaturated hydraulic conductivity data against which to test these predictions.

28901 (MLM–277) **Sonic decontamination.** Brodbeck, R.M.; Schommer, G.R. Mound Lab., Miamisburg, OH (United States). 25 Jan 1949. 8p. Sponsored by USDOE, Washington, DC (United States). DOE Contract AC24-88DP43495. Order Number DE96001529. Source: OSTI; NTIS; GPO Dep.

The supersonic method of cleaning glassware is an outgrowth of the fact that it has been heretofore impossible to manually clean ground glass and quartz joints because the activity became lodged in the small pores of the ground surfaces. It has been theorized that the nature of the forces binding polonium to the glass is similar to that of the chemical bond but are less intense. The problem then becomes one of finding a force greater than this binding energy, capable of freeing the activity from the glass. This has been accomplished by using frequencies of 100 cycles to 20 kc at a power output from 2 to 20 watts, passing through a citric acid solution (pH-2) into which the contaminated article is placed. The optimum results, using a tank with the dimensions 7 in. x 7 in. x 7 in. and 3 liters of solution, has been found at 200 cycles or harmonics of 200 cycles. Citric acid was used because of the fact that it forms a soluble complex with polonium. The frequencies used have been kept within the sonic range until enough data has been obtained and correlated to warrant the design and construction of more costly types of projectors (i.e., quartz crystals) and their allied components. This document detail initial test methodology and results.

28902 (MLM–2240(LD)) **Evaluation of coagulant aids at high pH.** Koenst, J.W.; Blane, D.E. Mound, Miamisburg, OH (United States). 30 Apr 1976. 7p. Sponsored by USDOE, Washington, DC (United States). DOE Contract AC24-88DP43495. Order Number DE96000799. Source: OSTI; NTIS; GPO Dep.

A series of tests was run on influent to the waste treatment facility, using various polyelectrolytes and organic polymeric coagulant aids. The influent wastewater originates in chemical process areas, janitorial sinks, process-area locker room showers, floor drains, and from the laundry. Previous tests on this waste had shown that Fe^{+3} and Ca^{+2} at pH 11.3 gave improved product quality. However, a suitable coagulant aid for use at high pH's was needed to obtain a rapid settling rate in the flocculation/sedimentation process. Results of the tests showed that Nalco-C627 gave a good decontamination factor while yielding rapid settling rates. Betz-1175 gave the best decontamination factors; however, its settling rate needs to be improved. Test results revealed decontamination was greater at pH 11.3 than at pH 10.1. It is recommended at this time, that Nalco-C627 be used with the Fe^{+3}, Ca^{+2} high pH system, and that further tests be performed on the Betz-1175.

28903 (NUREG/CP–0138, pp. 167-186) **Some concepts of model uncertainty for performance assessments of nuclear waste repositories.** Eisenberg, N.A. (Nuclear Regulatory Commission, Washington, DC (United States)); Sagar, B.; Wittmeyer, G.W. Nuclear Regulatory Commission, Washington, DC (United States). Div. of Safety Issue Resolution; Maryland Univ., College Park, MD (United States); EG and G Idaho, Inc., Idaho Falls, ID (United States). Oct 1994. (CONF-9310377–: Advanced topics in risk and reliability analysis, Annapolis, MD (United States), 20 Oct 1993). In *Proceedings of workshop I in advanced topics in risk and reliability analysis. Model uncertainty: Its characterization and quantification.* 242p. Source: OSTI; NTIS; INIS; GPO.

Models of the performance of nuclear waste repositories will be central to making regulatory decisions regarding the safety of such facilities. The conceptual model of repository performance is represented by mathematical relationships, which are usually implemented as one or more computer codes. A geologic system may allow many conceptual models, which are consistent with the observations. These conceptual models may or may not have the same mathematical representation. Experiences in modeling the performance of a waste repository representation. Experiences in modeling the performance of a waste repository (which is, in part, a geologic system), show that this non-uniqueness of conceptual models is a significant source of model uncertainty. At the same time, each conceptual model has its own set of parameters and usually, it is not be possible to completely separate model uncertainty from parameter uncertainty for the repository system. Issues related to the origin of model uncertainty, its relation to parameter uncertainty, and its incorporation in safety assessments are discussed from a broad regulatory perspective. An extended example in which these issues are explored numerically is also provided.

28904 (NUREG/CP–0142-Vol.3, pp. 2240-2255) **INJECT and the modeling of waste recycling processes.** Gracyalny, E.J. (Univ. of Wisconsin, Madison, WI (United States)); Corradini, M.L. Nuclear Regulatory Commission, Washington, DC (United States). Div. of Systems Technology; American Nuclear Society, La Grange Park, IL (United States); American Inst. of Chemical Engineers, New York, NY (United States); American Society of Mechanical Engineers, New York, NY (United States); Canadian Nuclear Society, Toronto, ON (Canada); European Nuclear Society (ENS), Bern (Switzerland); Atomic Energy Society of Japan, Tokyo (Japan); Japan Society of Multiphase Flow, Kyoto (Japan). Sep 1995. (CONF-950904–Vol.3: 7. international meeting on nuclear reactor thermal hydraulics, Saratoga, NY (United States), 10-15 Sep 1995). In *Proceedings of the 7th International Meeting on Nuclear Reactor Thermal-Hydraulics NURETH-7, Volume 3, Sessions 12-16.* 1001p. Source: OSTI; NTIS; INIS; GPO.

Enhancements were performed to the computer model CORCON to allow for more general energy and transport processes, thus

creating a general equilibrium, chemistry tool for a liquid pool with fluid injection. The summation of these model modifications are referred to as INJECT. It is believed that with these enhancements, INJECT becomes a useful tool to study waste management technologies and materials processing. A demonstration of such was performed with a simulation of pyrolysis and materials extraction of ion exchange resins produced by pressurized water reactors. A 5 kg pool consisting of iron, carbon and alumina was injected with CO_2 and contaminated resin, commonly known as styrene. The injection rates varied from 0.2-1.0 $_{min}^{L}$ for the CO_2 and 0.5-1.5 $_{min}^{g}$ for the resin. Simulation results indicated that the cesium and zinc contaminants were released as gases, cobalt would be in the metallic phase, cerium remained in the oxidic phase and manganese was found in both the oxidic and metallic phases.

28905 (NUREG/CR–6305) **BLT-EC (Breach, Leach Transport, and Equilibrium Chemistry), a finite-element model for assessing the release of radionuclides from low-level waste disposal units: Background, theory, and model description.** MacKinnon, R.J. (Brookhaven National Lab., Upton, NY (United States)); Sullivan, T.M.; Simonson, S.A.; Suen, C.J. Nuclear Regulatory Commission, Washington, DC (United States). Div. of Regulatory Applications; Brookhaven National Lab., Upton, NY (United States); California State Univ., Fresno, CA (United States). Aug 1995. 130p. Sponsored by Nuclear Regulatory Commission, Washington, DC (United States). DOE Contract AC02-76CH00016. (BNL-NUREG–52446). Source: OSTI; NTIS; INIS; GPO.

Performance assessment models typically account for the processes of sorption and dissolution-precipitation by using an empirical distribution coefficient, commonly referred to as K_d that combines the effects of all chemical reactions between solid and aqueous phases. In recent years, however, there has been an increasing awareness that performance assessments based solely on empirically based K_d models may be incomplete, particularly for applications involving radionuclides having sorption and solubility properties that are sensitive to variations in the in-situ chemical environment. To accommodate variations in the in-situ chemical environment, and to assess its impact on radionuclide mobility, it is necessary to model radionuclide release, transport, and chemical processes in a coupled fashion. This modeling has been done and incorporated into the two-dimensional, finite-element, computer code BLT-EC (Breach, Leach, Transport, Equilibrium Chemistry). BLT-EC is capable of predicting container degradation, waste-form leaching, and advective-dispersive, multispecies, solute transport. BLT-EC accounts for retardation directly by modeling the chemical processes of complexation, sorption, dissolution-precipitation, ion-exchange, and oxidation-reduction reactions. In this report we: (1) present a detailed description of the various physical and chemical processes that control the release and migration of radionuclides from shallow land LLW disposal facilities; (2) formulate the mathematical models that represent these processes; (3) outline how these models are incorporated and implemented in BLT-EC; and (4) demonstrate the application of BLT-EC on a set of example problems.

28906 (NUREG/CR–6356) **Hydraulic characterization of hydrothermally altered Nopal tuff.** Green, R.T. (Southwest Research Institute, San Antonio, TX (United States)); Meyer-James, K.A.; Rice, G. Electric Power Research Inst., Palo Alto, CA (United States); Southwest Research Inst., San Antonio, TX (United States). Center for Nuclear Waste Regulatory Analyses. Jul 1995. 40p. Sponsored by Nuclear Regulatory Commission, Washington, DC (United States). (CNWRA–94-027). Source: OSTI; NTIS; INIS; GPO.

Understanding the mechanics of variably saturated flow in fractured-porous media is of fundamental importance to evaluating the isolation performance of the proposed high-level radioactive waste repository for the Yucca Mountain site. Developing that understanding must be founded on the analysis and interpretation of laboratory and field data. This report presents an analysis of the unsaturated hydraulic properties of tuff cores from the Pena Blanca natural analog site in Mexico. The basic intent of the analysis was to examine possible trends and relationships between the hydraulic properties and the degree of hydrothermal alteration exhibited by the tuff samples. These data were used in flow simulations to evaluate the significance of a particular conceptual (composite) model and of distinct hydraulic properties on the rate and nature of water flow.

28907 (ORNL–6854) **Extraction of nitric acid, uranyl nitrate, and bismuth nitrate from aqueous nitric acid solutions with CMPO.** Spencer, B.B. Oak Ridge National Lab., TN (United States). Aug 1995. 223p. Sponsored by USDOE, Washington, DC (United States). DOE Contract AC05-84OR21400. Order Number DE96000899. Source: OSTI; NTIS; INIS; GPO Dep.

DOE sponsored development of the transuranium extraction (TRUEX) process for removing actinides from radioactive wastes. The solvent is a mixture of CMPO and TBP. Since the extraction characteristics of CMPO are not as well understood as those of TBP, the extraction of nitric acid, uranyl nitrate, and bismuth nitrate with CMPO (dissolved in n-dodecane) were studied. Results indicate that CMPO extracts nitric acid with a 1:1 stoichiometry; equilibrium constant is 2. 660±0.092 at 25 C, and extraction enthalpy is -5. 46±0.46 kcal/mol. Slope analysis indicates that uranyl nitrate extracts with a mixed equilibria of 1:1 and 2:1 stoichiometries in nearly equal proportion. Equil. constant of the 2: 1 extraction was $1.213 \times 10^6 \pm 3.56 \times 10^4$ at 25 C; reaction enthalpy was -9.610±0.594 kcal/mol. Nitration complexation constant is 8.412±0.579, with an enthalpy of -10.72±1.87 kcal/mol. Bismuth nitrate also extracts with a mixed equilibria of (perhaps) 1:1 and 2:1 stoichiometries. A 2:1 extraction equilibrium and a nitrate complexation adequately model the data. Kinetics and enthalpies were also measured.

28908 (ORNL/ER–183/A1) **Addendum to the health and safety plan for Waste Area Grouping 6 at Oak Ridge National Laboratory, Oak Ridge, Tennessee. Environmental Restoration Program.** Clark, C. Jr.; Burman, S.N.; Wilson, K.A. Oak Ridge National Lab., TN (United States). Aug 1995. 12p. Sponsored by USDOE, Washington, DC (United States). DOE Contract AC05-84OR21400. Order Number DE95017188. Source: OSTI; NTIS; INIS; GPO Dep.

There are three purposes for this addendum to the health and safety plan for Waste Area Grouping 6. The first purpose is to provide record of a corrective action response concerning an occurrence on WAG 6 in October 1994 (ORO-MMES-ENVRES-1994-0016.) This occurrence involved a precautionary evacuation of subcontractor field crews due to malfunctioning monitor alarms for organic vapors. The corrective action is to revise the WAG 6 Site health and safety plan to improve communications during emergency events. The second purpose is to incorporate any outstanding health and safety issues not addressed in the original health and safety plan for WAG 6 document (ORNL/ER-183). The only variance of note is tritium air monitoring in the Tumulus building. The tritium air monitor is added in this addendum as monitoring equipment for WAG 6 with description of action level and calibration. The third purpose of this addendum is to satisfy a condition of approval for the pending Nuclear Criticality Safety Assessment (NCSA) pertaining to KEMA fuel storage at WAG 6. This approval condition requires the following: "The location of the KEMA burial shall be recorded and maintained in a controlled document that identifies the quantity and the general physical conditions at the time of the entombment with an admonishment to obtain nuclear criticality safety guidance before altering the burial condition." In order to satisfy the approval, this document must be controlled. The predecessor to the pending NCSA is NSR No. 0002WM22001.

28909 (ORNL/ER–297) **Inactive Tanks Remediation Program strategy and plans for Oak Ridge National Laboratory, Oak Ridge, Tennessee. Environmental Restoration Program.** H and R Technical Associates, Inc., Oak Ridge, TN (United States); Oak Ridge National Lab., TN (United States). Jun 1995. 24p. Sponsored by USDOE, Washington, DC (United States). DOE Contract AC05-84OR21400. Order Number DE95017059. Source: OSTI; NTIS; INIS; GPO Dep.

The overall objective of the Inactive Tank Remediation Program is to remediate all LLLW tanks that have been removed fimn service to the extent practicable in accordance with the FFA and CERCLA requirements. Applicable or relevant and appropriate requirements (ARARs) will be addressed in choosing a remediation

alternative. Preference will be given to remedies that are highly reliable and provide long-term protection. Efforts will be directed toward permanently and significantly reducing the volume, toxicity, or mobility of hazardous substances, pollutants, and contaminants associated with the tank systems. Where indicated by operational or other restraints, interim measures short of full and complete remediation may be taken to maintain human health and ecological risks at acceptable levels until full remediation can be accomplished.

28910 (ORNL/ER–304) **Waste management plan for inactive LLLW tanks 3001-B, 3004-B, 3013, and T-30 at Oak Ridge National Laboratory, Oak Ridge, Tennessee. Environmental Restoration Program.** H and R Technical Associates, Inc., Oak Ridge, TN (United States); Oak Ridge National Lab., TN (United States). Jul 1995. 65p. Sponsored by USDOE, Washington, DC (United States). DOE Contract AC05-84OR21400. Order Number DE95016172. Source: OSTI; NTIS; INIS; GPO Dep.

This Project Waste Management Plan identifies the waste that is expected to be generated in connection with the removal and disposition of inactive liquid low-level radioactive waste tanks 3001-B, 3004-B, and T-30, and grouting of tank 3013 at the Oak Ridge National Laboratory and the isolation of these tanks' associated piping systems. The plan also identifies the organization, responsibilities, and administrative controls that will be followed to ensure proper handling of the waste.

28911 (ORNL/ER–306) **Inactive Tanks Remediation Program Batch I, Series I tanks 3001-B, 3004-B, 3013, and T-30 technical memorandum. Environmental Restoration Program.** H and R Technical Associates, Inc., Oak Ridge, TN (United States); Oak Ridge National Lab., TN (United States). May 1995. 21p. Sponsored by USDOE, Washington, DC (United States). DOE Contract AC05-84OR21400. Order Number DE95017049. Source: OSTI; NTIS; INIS; GPO Dep.

This technical memorandum provides information that can be used to make decisions concerning the disposition of four inactive tank systems that have been designated Batch 1, Series 1, by the Inactive Tanks Remediation Program team. The Batch I, Series 1, tanks are 3001-B, 3004-B, 3013, and T-30. The report offers viable alternatives for tank system disposition. The Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA) requires a Federal Facility Agreement (FFA) for federal facilities placed on the National Priorities List. The Oak Ridge Reservation was placed on that list on December 21, 1989, and the agreement was signed in November 1991 by DOE's Oak Ridge Operations Office, the US Environmental Protection Agency-Region IV, and the Tennessee Department of Environment and Conservation. The effective date of the FFA is January 1, 1992. One objective of the FFA is to ensure that inactive liquid low-level radioactive waste tank systems are evaluated and, if appropriate, remediated through the CERCLA process. The Inactive Tanks Remediation Program and the Gunite and Associated Tanks Project (GAAT) are the two efforts that will meet this FFA objective. This memorandum addresses tank systems within the Inactive Tanks Remediation Program. Separate CERCLA documentation addresses the tank systems within the GAAT Project.

28912 (ORNL/ER–307) **Quality Assurance Project Plan for the treatability study of in situ vitrification of Seepage Pit 1 in Waste Area Grouping 7 at Oak Ridge National Laboratory.** Oak Ridge National Lab., TN (United States). Jul 1995. 90p. Sponsored by USDOE, Washington, DC (United States). DOE Contract AC05-84OR21400. Order Number DE95017047. Source: OSTI; NTIS; INIS; GPO Dep.

Environmental Restoration Program.

This Quality Assurance Project Plan (QAPjP) establishes the quality assurance procedures and requirements to be implemented for the control of quality-related activities for Phase 3 of the Treatability Study (TS) of In Situ Vitrification (ISV) of Seepage Pit 1, ORNL Waste Area Grouping 7. This QAPjP supplements the Quality Assurance Plan for Oak Ridge National Laboratory Environmental Restoration Program by providing information specific to the ISV-TS. Phase 3 of the TS involves the actual ISV melt operations and posttest monitoring of Pit 1 and vicinity. Previously, Phase 1 activities were completed, which involved determining the boundaries of Pit 1, using driven rods and pipes and mapping the distribution of radioactivity using logging tools within the pipes. Phase 2 involved sampling the contents, both liquid and solids, in and around seepage Pit 1 to determine their chemical and radionuclide composition and the spatial distribution of these attributes. A separate QAPjP was developed for each phase of the project. A readiness review of the Phase 3 activities presented QAPjP will be conducted prior to initiating field activities, and an Operational Acceptance, Test (OAT) will also be conducted with no contamination involved. After, the OAT is complete, the ISV process will be restarted, and the melt will be allowed to increase with depth and incorporate the radionuclide contamination at the bottom of Pit 1. Upon completion of melt 1, the equipment will be shut down and mobilized to an adjacent location at which melt 2 will commence.

28913 (ORNL/ER–312) **Project management plan for inactive tanks 3001-B, 3004-B, 3013, and T-30 at Oak Ridge National Laboratory, Oak Ridge, Tennessee. Environmental Restoration Program.** Oak Ridge National Lab., TN (United States). Jul 1995. 21p. Sponsored by USDOE, Washington, DC (United States). DOE Contract AC05-84OR21400. Order Number DE95016167. Source: OSTI; NTIS; INIS; GPO Dep.

*This document identifies the roles and responsibilities of the project team members and identifies the project scope, schedule, and cost reporting activities for a maintenance activity to remove and dispose of three inactive liquid low-level radioactive waste (LLLW) system tanks and to isolate and fill one LLLW tank with grout. Tanks 3001-B, 3004-B, and T-30 are located in concrete vaults and tank 3013 is buried directly in the soil. The maintenance project consists of cutting the existing pipes attached to the tanks; capping the piping to be left in place; removing the tanks and filling the vaults with grout for tanks 3001-B, 3004-B, and T-30; and filling tank 3013 with grout. Because the LLLW line serving tank 3001-B will be needed for discharging the 3001 canal demineralizer back flush and regeneration waste to tank WC-19, tank 3001-B will be replaced with a section of piping.

28914 (ORNL/ER–329/V1) **Site investigation report for Waste Area Grouping 4 at Oak Ridge National Laboratory. Volume 1, Text: Environmental Restoration Program.** Oak Ridge National Lab., TN (United States). Aug 1995. 80p. Sponsored by USDOE, Washington, DC (United States). DOE Contract AC05-84OR21400. Order Number DE95017189. Source: OSTI; NTIS; INIS; GPO Dep.

Waste Area Grouping (WAG) 4 is one of 17 WAGs within and associated with Oak Ridge National Laboratory (ORNL). WAG 4 is located south of the main facility along Lagoon Road. WAG 4 consists of three separate areas: Solid Waste Storage Area (SWSA) 4, a shallow-land-burial ground containing radioactive and potentially hazardous wastes; an experimental Pilot Pit Area, which includes a pilot-scale testing pit; and sections of two abandoned underground pipelines used for transporting liquid, low-level, radioactive waste. SWSA 4 is the largest site at WAG 4, covering approximately 23 acres. In the 1950s, SWSA 4 received a variety of low- and high-activity wastes, including transuranic wastes, all buried in trenches and auger holes. Recent surface water data, collected during monitoring of the tributary to White Oak Creek as part of WAG 2 investigations as well as during previous studies conducted at WAG 4, indicate that a significant amount of ^{90}Sr is being released from the old burial trenches in SWSA 4. This release represents a significant portion of the ORNL off-site risk (DOE 1993). With recent corrective measures the proportion of the release has increased in 1995. A detailed discussion of the site history and previous investigations is presented in the WAG 4 Preliminary Assessment Report, ORNL/ER-271 (Energy Systems 1994b). In an effort to control the sources of the ^{90}Sr release and to reduce the off-site risk, a site investigation was initiated to pinpoint those trenches that are the most prominent ^{90}Sr sources.

28915 (ORNL/ER–329/V2) **Site investigation report for Waste Area Grouping 4 at Oak Ridge National Laboratory. Volume 2, Appendixes: Environmental Restoration Program.** Oak Ridge National Lab., TN (United States). Aug 1995. 200p. Sponsored by USDOE, Washington, DC (United States). DOE Contract AC05-84OR21400. Order Number DE95017190. Source: OSTI; NTIS; INIS; GPO Dep.

This report documents the UltraSonic Ranging and Data Systems (USRADS) survey conducted for radiological characterization of approximately 5 acres located at the Oak Ridge National Laboratory (ORNL) Waste Area Grouping (WAG) 4. The survey was conducted by Chemrad Tennessee Corporation under subcontract No. 7908-RS-00902 to CDM Federal Programs Corporation. The field survey began June 23, 1994 (Chemrad survey team was unable to actually enter field until June 24 awaiting sign-off of CDM plans by MMES) and was terminated on June 29, 1994. The designated survey area is located on the DOE X-10 facility and South of the main X-10 building complex. The entire north boundary of the site is adjacent to SWSA 4, with the Bath Tubbing Trench Seep Area (BTT) actually being a part of that SWSA (See Figure 1). Approximately one-third of the designated area was actually surveyed. The BTT area slopes moderately eastward toward a small stream in the WAG 4 area. The area is open and had recently been trimmed for the survey. The balance of the designated survey area lies along the small stream within WAG 4 and is densely wooded with heavy underbrush. The area had not been cleared or brushed. Survey reference points for the BTT area mere directly tied into the X-10 coordinate system while the t bale,ice of the designated survey area mere tied into an existing relative metric grid system. The designated area was surveyed for radiological characterization using near-surface gamma and beta detectors as well as an energy independent dosimeter. This report describes the survey method and presents the survey findings.

28916 (ORNL/M–4322) **What is plutonium stabilization, and what is safe storage of plutonium?** Forsberg, C.W. Oak Ridge National Lab., TN (United States). 29 Jun 1995. 41p. Sponsored by USDOE, Washington, DC (United States). DOE Contract AC05-84OR21400. Order Number DE96000835. Source: OSTI; NTIS; INIS; GPO Dep.

The end of the cold war has resulted in the shutdown of nuclear weapons production and the start of dismantlement of significant numbers of nuclear weapons. This, in turn, is creating an inventory of plutonium requiring interim and long-term storage. A key question is, "What is required for safe, multidecade, plutonium storage?" The requirements for storage, in turn, define what is needed to stabilize the plutonium from its current condition into a form acceptable for interim and long-term storage. Storage requirements determine if research is required to (1) define required technical conditions for interim and long-term storage and (2) develop or improve current stabilization technologies. Storage requirements depend upon technical, policy, and economic factors. The technical issues are complicated by several factors. Plutonium in aerosol form is highly hazardous. Plutonium in water is hazardous. The plutonium inventory is in multiple chemical forms–some of which are chemically reactive. Also, some of the existing storage forms are clearly unsuitable for storage periods over a few years. Gas generation by plutonium compounds complicates storage: (1) all plutonium slowly decays creating gaseous helium and (2) the radiation from plutonium decay can initiate many chemical reactions-some of which generate significant quantities of gases. Gas generation can pressurize sealed storage packages. Last nuclear criticality must be avoided.

28917 (ORNL/TM–12299) **Status of the ORNL liquid low-level waste management upgrades.** Robinson, S.M.; Kent, T.E.; DePaoli, S.M. Oak Ridge National Lab., TN (United States). Aug 1995. 33p. Sponsored by USDOE, Washington, DC (United States). DOE Contract AC05-84OR21400. Order Number DE96000849. Source: OSTI; NTIS; INIS; GPO Dep.

The strategy for management of the Oak Ridge National Laboratory's (ORNL's) radioactively contaminated liquid waste was reviewed. The latest information on waste characterization, regulations, US Department of Energy (DOE) budget guidance, and research and development programs was evaluated to determine how the strategy should be revised. Few changes are needed to update the strategy to reflect new waste characterization, research, and regulatory information. However, recent budget guidance from DOE indicates that minimum funding will not be sufficient to accomplish original objectives to upgrade the liquid low-level waste (LLLW) system to be in compliance with the Federal Facilities Agreement compliance, provide long-term LLLW treatment capability, and minimize Environmental Safety & Health risks. Options are presented that might allow the ORNL LLLW system to continue operations temporarily but significantly reduce its capabilities to handle emergency situations, provide treatment for new waste streams, and accommodate waste from the Environmental Restoration Program and from decontamination and decommissioning of surplus facilities. These options are also likely to increase worker radiation exposure, risk of environmental insult, and generation of solid waste for on-site and off-site disposal/storage beyond existing facility capacities. The strategy will be fully developed after receiving additional guidance. The proposed budget limitations are too severe to allow ORNL to meet regulatory requirements or continue operations long term.

28918 (ORNL/TM–13015) **Artificial magma program: Report on workshop held in Oak Ridge, Tennessee on March 29-30, 1994.** Naney, M.T.; Jacobs, G.K. Oak Ridge National Lab., TN (United States). Mar 1995. 25p. Sponsored by USDOE, Washington, DC (United States). DOE Contract AC05-84OR21400. (CONF-9403240–: Artificial Magma Program, Oak Ridge, TN (United States), 29-30 Mar 1994). Order Number DE96000851. Source: OSTI; NTIS; INIS; GPO Dep.

A workshop was organized and conducted in Oak Ridge, Tennessee, on March 29 and 30, 1994, to evaluate the use of in situ vitrification (ISV) technology to produce large silicate melts that would serve as analogs for natural magmas for the study of magmatic properties and processes. ISV technology would permit experiments to test hypotheses or provide new data that cannot be tested or obtained through bench-top experimentation or the study of natural systems. The scale of ISV melts is intermediate between that of natural lava lakes and laboratory crucible experiments, with melt volumes from 15 to 300 m^3 easily obtained. This approach permits investigation of dynamic processes which operate on scales difficult to simulate through bench-top experimentation and that are not amenable to direct observation or control in natural systems (e.g., degassing, convection, and crystal settling). Several aspects of the ISV process make it uniquely applicable for the study of magma systems. The process produces "containerless" silicate melts, which permits development of important analog components of natural magma systems including: partial melt zones, stopping, contact metamorphic haloes, and "hydrothermal" fluids. The lack of a melt "container" also enables use of standard field-scale geophysical instrumentation for studying the seismic and electrical properties of the melt and host materials. In addition, volatile and particulate emissions from the melt can be sampled using methods that avoid reaction with, and contamination by, host rocks. The consensus of the group was that the use of melts generated by ISV technology provided unique opportunities to advance the understanding of magmas and magmatic processes and warranted development of a proposal.

28919 (ORNL/TM–13078) **PCB extraction from ORNL tank WC-14 using a unique solvent.** Bloom, G.A.; Lucero, A.J.; Koran, L.J.; Turner, E.N. Oak Ridge National Lab., TN (United States). Sep 1995. 25p. Sponsored by USDOE, Washington, DC (United States). DOE Contract AC05-84OR21400. Order Number DE96000834. Source: OSTI; NTIS; INIS; GPO Dep.

This report summarizes the development work of the Engineering Development Section of the Chemical Technology Division at Oak Ridge National Laboratory (ORNL) for an organic extraction method for removing polychlorinated biphenyls (PCBs) from tank WC-14. Tank WC-14 is part of the ORNL liquid low-level radioactive tank waste system and does not meet new secondary containment and leak detection regulations. These regulations require the tank to be taken out of service, and remediated before tank removal. To remediate the tank, the PCBs must be removed; the tank contents can then be transferred to the Melton Valley Storage Tanks before final disposal. The solvent being used for the PCB extraction experiments is triethylamine, an aliphatic amine that is soluble in water below 60°F but insoluble in water above 90°F. This property will allow the extraction to be carried out under fully miscible conditions within the tank; then, after tank conditions have been changed, the solvent will not be miscible with water and phase separation will occur. Phase separation between sludge,

water, and solvent will allow solvent (loaded with PCBs) to be removed from the tank for disposal. After removing the PCBs from the sludge and removing the sludge from the tank, administrative control of the tank can be transferred to ORNL's Environmental Restoration Program, where priorities will be set for tank removal. Experiments with WC-14 sludge show that greater than 90% extraction efficiencies can be achieved with one extraction stage and that PCB concentration in the sludge can be reduced to below 2 ppm in three extractions. It is anticipated that three extractions will be necessary to reduce the PCB concentration to below 2 ppm during field applications. The experiments conducted with tank WC-14 sludge transferred less than 0.03% of the original alpha contamination and less than 0.002% of the original beta contamination.

28920 Apparatus for separating and collecting hydrogen gas. Carnes, J.R.; Nolen, R.L. 1993. Filed date 20 May 1993. U.S. Patent Application 8-066,398. 8p. Sponsored by USDOE, Washington, DC (United States). DOE Contract W-7405-ENG-36. Order Number DE95016427. Source: OSTI; NTIS (US Sales Only); GPO Dep.

Disclosed is an apparatus for separating and collecting hydrogen gas. A hydrogen-permeable membrane is used in combination with a trap therefor in order to separate hydrogen gas from a gas stream containing a mixture of gases. The use of a membrane selectively permeable to hydrogen, protects the trap from poisoning by other components in the gas stream by substantially preventing their reaching the trap. The combination is especially useful for tritium removal and storage, since β-resistant permeable membranes are now available.

28921 (PNC-TN–1100-94-002) **Proceedings of plenary session. International workshop on research and development of geological disposal.** Power Reactor and Nuclear Fuel Development Corp., Tokyo (Japan). 1995. 106p. (CONF-9311199–: International workshop on research and development of geological disposal, Tokai (Japan), 15-19 Nov 1993). Order Number DE96701392. Source: OSTI; NTIS; INIS.

This issue is the collection of the papers presented at the title meeting. The 8 of the presented papers are indexed individually. (J.P.N.).

28922 (PNC-TN–1100-94-003, pp. II/59-II/60) **Temperature dependence of hydraulic conductivity of compacted bentonite.** Kanno, Takeshi (Power Reactor and Nuclear Fuel Development Corp., Tokai, Ibaraki (Japan). Tokai Works); Takeuchi, Shinji; Suzuki, Hideaki. Power Reactor and Nuclear Fuel Development Corp., Tokyo (Japan). 1994. (CONF-9311199–: International workshop on research and development of geological disposal, Tokai (Japan), 15-19 Nov 1993). In *Proceedings of technical session on research and development of geological disposal.* 379p. Order Number DE95757546. Source: OSTI; NTIS; INIS.

The buffer material to be used for the geological disposal of high-level radioactive waste is required to retard groundwater movement through its low water permeability. The permeability has been evaluated as the hydraulic conductivity by applying the Darcy's law to the buffer material, however most of reported data are limited to a room temperature condition. The temperature of the buffer material is expected to increase due to the decay heat of the nuclear waste and thermal condition deep underground. Therefore, knowledge of temperature dependence of the hydraulic conductivity is important. In this study, the temperature dependence of the hydraulic conductivity of compacted bentonite, one of the most promising candidates for use as buffer material, is investigated. (J.P.N.).

28923 (PNC-TN–1100-94-003, pp. II/61-II/65) **Hydrogen migration test plan.** Tanai, Kenji (Power Reactor and Nuclear Fuel Development Corp., Tokai, Ibaraki (Japan). Tokai Works); Asano, Eiichi. Power Reactor and Nuclear Fuel Development Corp., Tokyo (Japan). 1994. (CONF-9311199–: International workshop on research and development of geological disposal, Tokai (Japan), 15-19 Nov 1993). In *Proceedings of technical session on research and development of geological disposal.* 379p. Order Number DE95757546. Source: OSTI; NTIS; INIS.

Short communication. HIGH-LEVEL RADIOACTIVE WASTES/underground disposal; CARBON STEELS; RADIONUCLIDE MIGRATION; RADIOACTIVE WASTE DISPOSAL; CORROSION; PACKAGING; CRACK PROPAGATION; PERMEABILITY; HYDROGEN; DIFFUSION

28924 (PNC-TN–1100-94-003, pp. IV/1-IV/5) **Integrated assessment - the SKB approach.** Papp, T. (Swedish Nuclear Fuel and Waste Management Co., Stockholm (Sweden)). Power Reactor and Nuclear Fuel Development Corp., Tokyo (Japan). 1994. (CONF-9311199–: International workshop on research and development of geological disposal, Tokai (Japan), 15-19 Nov 1993). In *Proceedings of technical session on research and development of geological disposal.* 379p. Order Number DE95757546. Source: OSTI; NTIS; INIS.

Short communication. SPENT FUELS/underground disposal; HIGH-LEVEL RADIOACTIVE WASTES/underground disposal; BENTONITE; RADIONUCLIDE MIGRATION; RADIOACTIVE WASTE DISPOSAL; ALPHA-BEARING WASTES; SITE CHARACTERIZATION; SAFETY; GEOLOGIC SURVEYS

28925 (PNC-TN–1100-94-003, pp. IV/29-IV/36) **Integrated assessment - Japanese approach.** Ishiguro, K. (Power Reactor and Nuclear Fuel Development Corp., Tokyo (Japan)); Umeki, H.; Sakuma, H. Power Reactor and Nuclear Fuel Development Corp., Tokyo (Japan). 1994. (CONF-9311199–: International workshop on research and development of geological disposal, Tokai (Japan), 15-19 Nov 1993). In *Proceedings of technical session on research and development of geological disposal.* 379p. Order Number DE95757546. Source: OSTI; NTIS; INIS.

Integrated assessment is carried out at all stages in the radioactive waste repository programme. At the moment, Japanese management programme for the geological disposal of the high-level radioactive waste (HLW) is in a generic R and D phase in which particular site or rock type has not yet been focused. The implementing organization for the geological disposal of HLW will be established around the year 2000, which will then initiate repository siting project. The important role of the current integrated assessment in the Japanese programme is therefore to evaluate the technical feasibility of the multi-barrier concept by summarizing the results of the R and D studies obtained to date. This aims at promoting a greater degree of public understanding. It also identifies future R and D issues and provides information for siting projects. For these purposes, Power Reactor and Nuclear Fuel Development Corporation (PNC) issued the first progress report, PNC/H-3, in September 1992. In this paper, the framework of H-3 integrated assessment will be described to discuss some issues related to confidence building in the assessment results. (J.P.N).

28926 (PNL–10213) **Organic tank safety project: Preliminary results of energetics and thermal behavior studies of model organic nitrate and/or nitrite mixtures and a simulated organic waste.** Scheele, R.D.; Sell, R.L.; Sobolik, J.L.; Burger, L.L. Pacific Northwest Lab., Richland, WA (United States). Aug 1995. 146p. Sponsored by USDOE, Washington, DC (United States). DOE Contract AC06-76RL01830. Order Number DE95017064. Source: OSTI; NTIS; INIS; GPO Dep.

As a result of years of production and recovery of nuclear defense materials and subsequent waste management at the Hanford Site, organic-bearing radioactive high-level wastes (HLW) are currently stored in large (up to 3. ML) single-shell storage tanks (SSTs). Because these wastes contain both fuels (organics) and the oxidants nitrate and nitrite, rapid energetic reactions at certain conditions could occur. In support of Westinghouse Hanford Company's (WHC) efforts to ensure continued safe storage of these organic- and oxidant-bearing wastes and to define the conditions necessary for reactions to occur, we measured the thermal sensitivities and thermochemical and thermokinetic properties of mixtures of selected organics and sodium nitrate and/or nitrite and a simulated Hanford organic-bearing waste using thermoanalytical technologies. These thermoanalytical technologies are used by chemical reactivity hazards evaluation organizations within the chemical industry to assess chemical reaction hazards.

28927 (PNL–10388) **Organic analysis of ambient samples collected near Tank 241-C-103: Results from samples collected on May 12, 1994.** Clauss, T.W.; Ligotke, M.W.; McVeety, B.D.; Lucke, R.B.; Young, J.S.; McCulloch, M.; Fruchter, J.S.; Goheen, S.C. Pacific Northwest Lab., Richland, WA (United States).

Jun 1995. 21p. Sponsored by USDOE, Washington, DC (United States). DOE Contract AC06-76RL01830. Order Number DE95015771. Source: OSTI; NTIS; INIS; GPO Dep.

This report describes organic analyses results from ambient samples collected both upwind and through the vapor sampling system (VSS) near Hanford waste storage Tank 241-C-103 (referred to as Tank C-103). The results described here were obtained to support safety and toxicological evaluations. A summary of the results for inorganic and organic analytes is listed. Quantitative results were obtained for organic compounds. Five organic tentatively identified compounds (TICS) were observed above the detection limit of (ca.) 10 ppbv, but standards for most of these were not available at the time of analysis, and the reported concentrations are semiquantitative estimates. In addition, we looked for the 40 standard TO-14 analytes. We observed 39. Of these, only one was observed above the 2-ppbv calibrated instrument detection limit. Dichloromethane was above the detection limits using both methods, but the result from the TO-14 method is traceable to a standard gas mixture and is considered more accurate. Organic analytes were found only in the sample collected through the VSS, suggesting that these compounds were residual contamination from a previous sampling job. Detailed descriptions of the results appear in the text.

28928 (PNL–10505) **Vapor space characterization of waste tank 241-BY-110: Results for samples collected on 11/11/94.** Clauss, T.W. (and others); Ligotke, M.W.; Pool, K.H. Pacific Northwest Lab., Richland, WA (United States). Jun 1995. 40p. Sponsored by USDOE, Washington, DC (United States). DOE Contract AC06-76RL01830. Order Number DE95015445. Source: OSTI; NTIS; INIS; GPO Dep.

This report describes inorganic and organic analyses results from samples obtained from the headspace of the Hanford waste storage Tank 241-BY-110 (referred to as Tank BY-110). The results described here were obtained to support safety and toxicological evaluations. A summary of the results for inorganic and organic analytes is listed in Table 1. Detailed descriptions of the results appear in the text. Quantitative results were obtained for the inorganic compounds ammonia (NH_3), nitrogen dioxide (NO_2), nitric oxide (NO), and water (H_2O). Sampling for hydrogen cyanide (HCN) and sulfur oxides (SO_x) was not requested. In addition, we looked for the 40 TO-14 compounds plus an additional 15 analytes. Of these, 10 were observed above the 5-ppbv reporting cutoff. Forty-six organic tentatively identified compounds (TICS) were observed above the reporting cutoff of (ca.) 10 ppbv, and are reported with concentrations that are semiquantative estimates based on internal standard response factors. The 10 organic analytes with the highest estimated concentrations are listed and account for approximately 78% of the total organic components in Tank BY-110. Two permanent gases, carbon dioxide (CO_2) and nitrous oxide (N_2O), were also detected.

28929 (PNL–10510) **Redox reaction and foaming in nuclear waste glass melting.** Ryan, J.L. Pacific Northwest Lab., Richland, WA (United States). Aug 1995. 50p. Sponsored by USDOE, Washington, DC (United States). DOE Contract AC06-76RL01830. Order Number DE96000871. Source: OSTI; NTIS; INIS; GPO Dep.

This document was prepared by Pacific Northwest Laboratory (PNL) and is an attempt to analyze and estimate the effects of feed composition variables and reducing agent variables on the expected chemistry of reactions occurring in the cold cap and in the glass melt in the nuclear waste glass Slurry-fed, joule-heated melters as they might affect foaming during the glass-making process. Numerous redox reactions of waste glass components and potential feed additives, and the effects of other feed variables on these reactions are reviewed with regard to their potential effect on glass foaming. A major emphasis of this report is to examine the potential positive or negative aspects of adjusting feed with formic acid as opposed to other feed modification techniques including but not limited to use of other reducing agents. Feed modification techniques other than the use of reductants that should influence foaming behavior include control of glass melter feed pH through use of nitric acid. They also include partial replacement of sodium salts by lithium salts. This latter action (b) apparently lowers glass viscosity and raises surface tension. This replacement should decrease foaming by decreasing foam stability.

28930 (PNL–10587) **Vapor space characterization of waste tank 241-S-102: Results from samples collected on 3/14/95.** Pool, K.H. (and others); McVeety, B.D.; Clauss, T.W. Pacific Northwest Lab., Richland, WA (United States). Oct 1995. 32p. Sponsored by USDOE, Washington, DC (United States). DOE Contract AC06-76RL01830. Order Number DE96001138. Source: OSTI; NTIS; INIS; GPO Dep.

This report describes inorganic and organic analyses results from samples obtained from the headspace of the Hanford waste storage Tank 241-S-102 (referred to as Tank S-102). The results described here were obtained to support safety and toxicological evaluations. A summary of the results for inorganic and organic analytes is listed in Table 1. Detailed descriptions of the results appear in the text. Quantitative results were obtained for the inorganic compounds ammonia (NH_3), nitrogen dioxide (NO_2), nitric oxide (NO), and water (H_2O). Sampling for hydrogen cyanide (HCN) and sulfur oxides (SO_x) was not requested. In addition, quantitative results were obtained for the 39 TO-14 compounds plus an additional 14 analytes. Of these, 11 were observed above the 5-ppbv reporting cutoff. Eleven tentatively identified compounds (TICs) were observed above the reporting cutoff of (ca.) 10 ppbv and are reported with concentrations that are semiquantitative estimates based on internal-standard response factors. The 10 organic analytes with the highest estimated concentrations are listed in Table 1 and account for approximately 95% of the total organic components in Tank S-102. Two permanent gases, hydrogen (H_2) and nitrous oxide (N_2O), were also detected.

28931 (PNL–10635) **Review of alternative residual contamination guides for the 324 Building B-Cell Cleanout Project. Phase 1.** Vargo, G.J.; Durham, J.S.; Brackenbush, L.W. Pacific Northwest Lab., Richland, WA (United States). Sep 1995. 19p. Sponsored by USDOE, Washington, DC (United States). DOE Contract AC06-76RL01830. Order Number DE96000199. Source: OSTI; NTIS; INIS; GPO Dep.

This report provides a proposed residual contamination guide (RCG) for the 324 Building B-Cell Cleanout Project, Phase 1, at the Hanford Site. The RCG is expressed as a fraction of the amount of highly dispersible radioactive material that would result in offsite doses equal to the Pacific Northwest Laboratory radiological risk guidelines following the worst credible accident scenario for release of the holdup material. The proposed RCG is 10^{-1} to 10^{-2} of the PNL radiological risk guidelines. As part of the development of the RCG, a number of factors were considered. These include the need to provide an appropriate level of flexibility for other activities within the 324 Building that could contribute to the facility's overall radiological risk, uncertainties inherent in safety analyses, and the possible contribution of other 300 Area facilities to overall radiological risk. Because of these factors and the nature of the cleanout project, the RCG is expressed as a range rather than a point value. This report also provides guidance on determining conformance to the RCG, including inspection and measurement techniques, quality assurance requirements, and consideration of uncertainty.

28932 (PNL–10642) **Vapor space characterization of waste tank 241-BX-104: Results from samples collected on 12/30/94.** Pool, K.H. (and others); Ligotke, M.W.; McVeety, B.D. Pacific Northwest Lab., Richland, WA (United States). Oct 1995. 36p. Sponsored by USDOE, Washington, DC (United States). DOE Contract AC06-76RL01830. Order Number DE96001134. Source: OSTI; NTIS; INIS; GPO Dep.

This report describes inorganic and organic analyses results from samples obtained from the headspace of the Hanford waste storage Tank 241-BX-104 (referred to as Tank BX-104). The results described here were obtained to support safety and toxicological evaluations. A summary of the results for inorganic and organic analytes is listed in Table 1. Detailed descriptions of the results appear in the text. Quantitative results were obtained. for the inorganic compounds ammonia (NH_3), nitrogen dioxide (NO_2), nitric oxide (NO), and water (H_2O). Sampling for hydrogen cyanide (HCN) and sulfur oxides (SOx) was not requested. In addition, quantitative results were obtained for the 39 TO-14 compounds plus an additional 14 analytes. Of these, 13 were observed above the 5-ppbv reporting cutoff. Sixty-six organic tentatively identified compounds (TICs) were observed above the reporting cutoff of

(ca.) 10 ppbv and are reported with concentrations that are semiquantitative estimates based on internal-standard response factors. The 10 organic analytes, with the highest estimated concentrations are listed in Table 1 and account for approximately 70% of the total organic components in Tank BX-104. Two permanent gases, carbon dioxide (CO_2) and nitrous oxide (N_2O), were also detected.

28933 (PNL–10643) **Vapor space characterization of waste tank 241-C-112: Results from samples collected on 8/11/94.** Ligotke, M.W. (and others); McVeety, B.D.; Pool, K.H. Pacific Northwest Lab., Richland, WA (United States). Oct 1995. 26p. Sponsored by USDOE, Washington, DC (United States). DOE Contract AC06-76RL01830. Order Number DE96001137. Source: OSTI; NTIS; INIS; GPO Dep.

This report describes organic analyses results from samples obtained from the headspace of the Hanford waste storage Tank 241-C-112 (referred to as Tank C-112). The results described here were obtained to support safety and toxicological evaluations. A summary of the results for inorganic and organic analytes is listed in Table 1. Detailed descriptions of the results appear in the text. Quantitative results were obtained for the inorganic compounds ammonia (NH_3), nitrogen dioxide (NO_2), nitric oxide (NO), and water (H_2O). Sampling for hydrogen cyanide (HCN) and sulfur oxides (SO_x) was not requested. Organic compounds were also quantitatively determined. Five organic tentatively identified compounds (TICs) were observed above the detection limit of (ca.) 10 ppbv, but standards for most of these were not available at the time of analysis, and the reported concentrations are semiquantitative estimates. In addition, we looked for the 40 standard TO-14 analytes. None were observed above the 2-ppbv detection limit. The five organic analytes with the highest concentration are listed in Table 1 and account for 100% of the total organic components in Tank C-112.

28934 (PNL–10644) **Vapor space characterization of waste tank 241-TY-103: Results from samples collected on 4/11/95.** Ligotke, M.W. (and others); Clauss, T.W.; Pool, K.H. Pacific Northwest Lab., Richland, WA (United States). Oct 1995. 33p. Sponsored by USDOE, Washington, DC (United States). DOE Contract AC06-76RL01830. Order Number DE96001135. Source: OSTI; NTIS; INIS; GPO Dep.

This report describes inorganic and organic analyses results from samples obtained from the headspace of the Hanford waste storage Tank 241-TY-103 (referred to as Tank TY-103). The results described here were obtained to support safety and toxicological evaluations. A summary of the results for inorganic and organic analytes is listed in Table 1. Detailed descriptions of the results appear in the text. Quantitative results were obtained for the inorganic compounds ammonia (NH_3), nitrogen dioxide (NO_2), nitric oxide (NO), and water (H_2O). Sampling for hydrogen cyanide (HCN) and sulfur oxides (SO_x) was not requested. In addition, quantitative results were obtained for the 39 TO-14 compounds plus an additional 14 analytes. Of these, 16 were observed above the 5-ppbv reporting cutoff. Sixteen tentatively identified compounds (TICs) were observed above the reporting cutoff of (ca.) 10 ppbv and are reported with concentrations that are semiquantitative estimates based on internal-standard response factors. The 10 organic analytes with the highest estimated concentrations are listed in Table 1 and account for approximately 95% of the total organic components in Tank TY-103. Two permanent gases, carbon dioxide (CO_2) and nitrous oxide (N_2O), were also detected.

28935 (PNL–10666) **Literature review of arc/plasma, combustion, and joule-heated melter vitrification systems.** Freeman, C.J.; Abrigo, G.P.; Shafer, P.J.; Merrill, R.A. Pacific Northwest Lab., Richland, WA (United States). Jul 1995. 60p. Sponsored by USDOE, Washington, DC (United States). DOE Contract AC06-76RL01830. Order Number DE95017598. Source: OSTI; NTIS; INIS; GPO Dep.

This report provides reviews of papers and reports for three basic categories of melters: arc/plasma-heated melters, combustion-heated melters, and joule-heated melters. The literature reviewed here represents those publications which may lend insight to phase I testing of low-level waste vitrification being performed at the Hanford Site in FY 1995. For each melter category, information from those papers and reports containing enough information to determine steady-state mass balance data is tabulated at the end of each section. The tables show the composition of the feed processed, the off-gas measured via decontamination factors, gross energy consumptions, and processing rates, among other data.

28936 (PNL–10683) **Thermal modeling of tanks 241-AW-101 and 241-AN-104 with the TEMPEST code.** Antoniak, Z.I.; Recknagle, K.P. Pacific Northwest Lab., Richland, WA (United States). Jul 1995. 21p. Sponsored by USDOE, Washington, DC (United States). DOE Contract AC06-76RL01830. Order Number DE95016038. Source: OSTI; NTIS; INIS; GPO Dep.

The TEMPEST code was exercised in a preliminary study of double-shell Tanks 241 -AW-101 and 241-AN-104 thermal behavior. The two-dimensional model used is derived from our earlier studies on heat transfer from Tank 241-SY-101. Several changes were made to the model to simulate the waste and conditions in 241-AW-101 and 241-AN-104. The nonconvective waste layer was assumed to be 254 cm (100 in.) thick for Tank 241-AW-101, and 381 cm (150 in.) in Tank 241-AN-104. The remaining waste was assumed, for each tank, to consist of a convective layer with a 7.6-cm (3-inch) crust on top. The waste heat loads for 241-AW-101 and 241-AN-104 were taken to be 10 kW (3.4E4 Btu/hr) and 12 kW (4.0E4 Btu/hr), respectively. Present model predictions of maximum and convecting waste temperatures are within 1.7°C (3°F) of those measured in Tanks 241-AW-101 and 241-AN-104. The difference between the predicted and measured temperature is comparable to the uncertainty of the measurement equipment. These models, therefore, are suitable for estimating the temperatures within the tanks in the event of changing air flows, waste levels, and/or waste configurations.

28937 (PNL–10692) **AREST-CT V1.0 software verification.** Chen, Y.; Engel, D.W.; McGrail, B.P.; Lessor, K.S. Pacific Northwest Lab., Richland, WA (United States). Jul 1995. 100p. Sponsored by USDOE, Washington, DC (United States). DOE Contract AC06-76RL01830. Order Number DE95017596. Source: OSTI; NTIS; INIS; GPO Dep.

The Analyzer for Radionuclide Source-Term with Chemical Transport (AREST-CT) is a scientific computer code designed for performance assessments of engineered barrier system (EBS) concepts for the underground storage of nuclear waste, including high-level, intermediate, and low-level wastes. The AREST-CT code has features for analyzing the degradation of and release of radionuclides from the waste form, chemical reactions that depend on time and space, and transport of the waste and other products through the EBS. This document provides a description of the verification testing that has been performed on the initial version of ARESTCT (V1.0). Software verification is the process of confirming that the models and algorithms have been correctly implemented into a computer code. Software verification for V1.0 consisted of testing the individual modules (unit tests) and a test of the fully-coupled model (integration testing). The integration test was done by comparing the results from AREST-CT with the results from the reactive transport code CIRF.A. The test problem consisted of a 1-D analysis of the release, transport, and precipitation of ^{99}Tc in an idealized LLW disposal system. All verification tests showed that AREST-CT works properly and in accordance with design specifications.

28938 (PNL–10694) **Bayesian methods for the combination of core sampling data with historical models for tank characterization.** York, J.C. (Pacific Northwest Lab., Richland, WA (United States)); Remund, K.M.; Chen, G.; Simpson, B.C.; Brown, T.M. Pacific Northwest Lab., Richland, WA (United States). Jul 1995. 23p. Sponsored by USDOE, Washington, DC (United States). DOE Contract AC06-76RL01830. Order Number DE95017600. Source: OSTI; NTIS; INIS; GPO Dep.

A wide variety of information is available on the contents of the nuclear waste tanks at the Hanford site. This report describes an attempt to combine several sources of information using a Bayesian statistical approach. This methodology allows the combination of multiple disparate information sources. After each source of information is summarized in terms of a probability distribution function (pdf), Bayes' theorem is applied to combine them. This approach has been applied to characterizing tanks B-110, B-111, and B-201. These tanks were chosen for their simple waste matrices: B-110 and B-111 contain mostly 2C waste, and B-201 contains

mostly 224 waste. Additionally,, the results of this analysis axe used to make predictions for tank T-111 (which contains both 2C and 224 waste). These predictions are compared to the estimates based on core samples from tank T-111.

28939 (PNL–10696) **Ferrocyanide Safety Program cyanide speciation studies. Final report.** Bryan, S.A. (and others); Pool, K.H.; Bryan, S.L. Pacific Northwest Lab., Richland, WA (United States). Jul 1995. 40p. Sponsored by USDOE, Washington, DC (United States). DOE Contract AC06-76RL01830. Order Number DE96001154. Source: OSTI; NTIS; INIS; GPO Dep.

This report summarizes Pacific Northwest Laboratory's fiscal year (FY) 1995 progress toward developing and implementing methods to identify and quantify cyanide species in ferrocyanide tank waste. This work was conducted for Westinghouse Hanfbrd Company's (WHC's) Ferrocyanide Safety Program. Currently, there are 18 high-level waste storage tanks at the US Department of Energy's Hanford Site that are on a Ferrocyanide Tank Watchlist because they contain an estimated 1000 g-moles or more of precipitated ferrocyanide. In the presence of oxidizing material such as sodium nitrate or nitrite, ferrocyanide can be made to react exothermally by heating it to high temperatures or by applying an electrical spark of sufficient energy (Cady 1993). However, fuel, oxidizers, and temperature are all important parameters. If fuel, oxidizers, or high temperatures (initiators) are not present in sufficient amounts, then a runaway or propagating reaction cannot occur. To bound the safety concern, methods are needed to definitively measure and quantitate ferrocyanide concentration present within the actual waste. The target analyte concentration for cyanide in waste is approximately 0.1 to 15 wt % (as cyanide) in the original undiluted sample. After dissolution of the original sample and appropriate dilutions, the concentration range of interest in the analytical solutions can vary between 0.001 to 0.1 wt % (as cyanide). In FY 1992, 1993, and 1994, two solution (wet) methods were developed based on Fourier transform infrared (FTIR) spectroscopy and ion chromatography (IC); these methods were chosen for further development activities. The results of these activities are described.

28940 (PNL–10697) **Ferrocyanide tank safety program: Cesium uptake capacity of simulated ferrocyanide tank waste. Final report.** Burgeson, I.E.; Bryan, S.A. Pacific Northwest Lab., Richland, WA (United States). Jul 1995. 35p. Sponsored by USDOE, Washington, DC (United States). DOE Contract AC06-76RL01830. Order Number DE96000750. Source: OSTI; NTIS; INIS; GPO Dep.

The objective of this project is to determine the capacity for ^{137}Cs uptake by mixed metal ferrocyanides present in Hanford Site waste tanks, and to assess the potential for aggregation of these ^{137}Cs-exchanged materials to form "hot-spots" in the tanks. This research, performed at Pacific Northwest Laboratory (PNL) for Westinghouse Hanford Company, stems from concerns regarding possible localized radiolytic heating within the tanks. After ferrocyanide was added to 18 high-level waste tanks in the 1950s, some of the ferrocyanide tanks received considerable quantities of saltcake waste that was rich in ^{137}Cs. If radioactive cesium was exchanged and concentrated by the nickel ferrocyanide present in the tanks, the associated heating could cause tank temperatures to rise above the safety limits specified for the ferrocyanide-containing tanks, especially if the supernate in the tanks is pumped out and the waste becomes drier.

28941 (PNL–10712) **Washing and caustic leaching of Hanford tank sludges: Results of FY 1995 studies.** Rapko, B.M.; Lumetta, G.J.; Wagner, M.J. Pacific Northwest Lab., Richland, WA (United States). 11 Aug 1995. 150p. Sponsored by USDOE, Washington, DC (United States). DOE Contract AC06-76RL01830. Order Number DE95017592. Source: OSTI; NTIS; INIS; GPO Dep.

During the past few years, the primary mission at the US Department of Energy's Hanford Site has changed from producing plutonium to environmental restoration. Large volumes of high-level radioactive wastes (HLW), generated during past Pu production and other operations, are stored in underground tanks on site. The current plan for remediating the Hanford tank farms consists of waste retrieval, pretreatment, treatment (immobilization), and disposal. The HLW will be immobilized in a borosilicate glass matrix; the resulting glass canisters will then be disposed of in a geologic repository. Because of the expected high cost of HLW immobilization and disposal, pretreatment processes will be implemented to reduce the volume of borosilicate glass produced in processing the tank wastes. This document describes sludge washing and caustic leaching tests conducted in FY 1995 at the Pacific Northwest Laboratory (PNL) at the request of Westinghouse Hanford Company. These tests were performed using sludges from seven Hanford waste tanks – B-111, BX-107, C-103, S-104, SY-103, T-104, and T-111. The primary and secondary types of waste stored in each of these tanks are given in Table 1. 1. The data collected in this effort will be used to support the March 1998 Tri-Party Agreement decision on the extent of pretreatment to be performed on the Hanford tank sludges (Ecology, EPA, and DOE 1994).

28942 (PNL–10725) **Scoring methods and results for qualitative evaluation of public health impacts from the Hanford high-level waste tanks. Integrated Risk Assessment Program.** Buck, J.W.; Gelston, G.M.; Farris, W.T. Pacific Northwest Lab., Richland, WA (United States). Sep 1995. 40p. Sponsored by USDOE, Washington, DC (United States). DOE Contract AC06-76RL01830. Order Number DE96001200. Source: OSTI; NTIS; INIS; GPO Dep.

The objective of this analysis is to qualitatively rank the Hanford Site high-level waste (HLW) tanks according to their potential public health impacts through various (groundwater, surface water, and atmospheric) exposure pathways. Data from all 149 single-shell tanks (SSTs) and 23 of the 28 double-shell tanks (DSTs) in the Tank Waste Remediation System (TWRS) Program were analyzed for chemical and radiological carcinogenic as well as chemical noncarcinogenic health impacts. The preliminary aggregate score (PAS) ranking system was used to generate information from various release scenarios. Results based on the PAS ranking values should be considered relative health impacts rather than absolute risk values.

28943 (PNL–10740) **Gas bubble retention and its effect on waste properties: Retention mechanisms, viscosity, and tensile and shear strengths.** Gauglitz, P.A. (and others); Rassat, S.D.; Powell, M.R. Pacific Northwest Lab., Richland, WA (United States). Aug 1995. 140p. Sponsored by USDOE, Washington, DC (United States). DOE Contract AC06-76RL01830. Order Number DE95017707. Source: OSTI; NTIS; INIS; GPO Dep.

Several of the underground nuclear storage tanks at Hanford have been placed on a flammable gas watch list, because the waste is either known or suspected to generate, store, and episodically release flammable gases. Because retention and episodic release of flammable gases from these tanks containing radioactive waste slurries are critical safety concerns, Pacific Northwest Laboratory (PNL) is studying physical mechanisms and waste properties that contribute to the episodic gas release from these storage tanks. This study is being conducted for Westinghouse Hanford Company as part of the PNL Flammable Gas project. Previous investigations have concluded that gas bubbles are retained by the slurry or sludge that has settled at the bottom of the tanks; however, the mechanisms responsible for the retention of these bubbles are not well understood. Understanding the rheological behavior of the waste, particularly of the settled sludge, is critical to characterizing the tendency of the waste to retain gas bubbles and the dynamics of how these bubbles are released from the waste. The presence of gas bubbles is expected to affect the rheology of the sludge, specifically its viscosity and tensile and shear strengths, but essentially no literature data are available to assess the effect of bubbles. The objectives of this study were to conduct experiments and develop theories to understand better how bubbles are retained by slurries and sludges, to measure the effect of gas bubbles on the viscosity of simulated slurries, and to measure the effect of gas bubbles on the tensile and shear strengths of simulated slurries and sludges. In addition to accomplishing these objectives, this study developed correlations, based on the new experimental data, that can be used in large-scale computations of waste tank physical phenomena.

28944 (PNL–10743) **1995 Baseline solid waste management system description.** Anderson, G.S.; Konynenbelt, H.S. Pacific Northwest Lab., Richland, WA (United States). Sep 1995. 50p. Sponsored by USDOE, Washington, DC (United States). DOE

Contract AC06-76RL01830. Order Number DE96000203. Source: OSTI; NTIS; INIS; GPO Dep.

This provides a detailed solid waste system description that documents the treatment, storage, and disposal (TSD) strategy for managing Hanford's solid low-level waste, low-level mixed waste, transuranic and transuranic mixed waste, and greater-than-Class III waste. This system description is intended for use by managers of the solid waste program, facility and system planners, as well as system modelers. The system description identifies the TSD facilities that constitute the solid waste system and defines these facilities' interfaces, schedules, and capacities. It also provides the strategy for treating each of the waste streams generated or received by the Hanford Site from generation or receipt through final destination.

28945 (PNL–10744) **Synthesis, structural characterization, and performance evaluation of resorcinol-formaldehyde (R-F) ion-exchange resin.** Hubler, T.L.; Franz, J.A.; Shaw, W.J.; Bryan, S.A.; Hallen, R.T.; Brown, G.N.; Bray, L.A.; Linehan, J.C. Pacific Northwest Lab., Richland, WA (United States). Aug 1995. 55p. Sponsored by USDOE, Washington, DC (United States). DOE Contract AC06-76RL01830. Order Number DE96000200. Source: OSTI; NTIS; INIS; GPO Dep.

The 177 underground storage tanks at the DOE's Hanford Site contain an estimated 180 million tons of high-level radioactive wastes. It is desirable to remove and concentrate the highly radioactive fraction of the tank wastes for vitrification. Resorcinol-formaldehyde (R-F) resin, an organic ion-exchange resin with high selectivity and capacity for the cesium ion, which is a candidate ion-exchange material for use in remediation of tank wastes. The report includes information on the structure/function analysis of R-F resin and the synthetic factors that affect performance of the resin. CS-100, a commercially available phenol-formaldehyde (P-F) resin, and currently the baseline ion-exchanger for removal of cesium ion at Hanford, is compared with the R-F resin. The primary structural unit of the R-F resin was determined to consist of a 1,2,3,4-tetrasubstituted resorcinol ring unit while CS-100, was composed mainly of a 1,2,4-trisubstituted ring. CS-100 shows the presence of phenoxy-ether groups, and this may account for the much lower decontamination factor of CS-100 for cesium ion. Curing temperatures for the R-F resin were found to be optimal at 105–130C. At lower temperatures, insufficient curing, hence crosslinking, of the polymer resin occurs and selectivity for cesium drops. Curing at elevated temperatures leads to chemical degradation. Optimal particle size for R-F resin is in the range of 20–50 mesh-sized particles. R-F resin undergoes chemical degradation or oxidation which destroys ion-exchange sites. The ion-exchange sites (hydroxyl groups) are converted to quinones and ketones. CS-100, though it has much lower performance for cesium ion-exchange, is significantly more chemically stable than R-F resin. To gamma radiation, CS-100 is more radiolytically stable than R-F resin.

28946 (PNL–10745) **Leach test of cladding removal waste grout using Hanford groundwater.** Serne, R.J.; Martin, W.J.; Legore, V.L. Pacific Northwest Lab., Richland, WA (United States). Sep 1995. 300p. Sponsored by USDOE, Washington, DC (United States). DOE Contract AC06-76RL01830. Order Number DE96000263. Source: OSTI; NTIS; INIS; GPO Dep.

This report describes laboratory experiments performed during 1986-1990 designed to produce empirical leach rate data for cladding removal waste (CRW) grout. At the completion of the laboratory work, funding was not available for report completion, and only now during final grout closeout activities is the report published. The leach rates serve as inputs to computer codes used in assessing the potential risk from the migration of waste species from disposed grout. This report discusses chemical analyses conducted on samples of CRW grout, and the results of geochemical computer code calculations that help identify mechanisms involved in the leaching process. The semi-infinite solid diffusion model was selected as the most representative model for describing leaching of grouts. The use of this model with empirically derived leach constants yields conservative predictions of waste release rates, provided no significant changes occur in the grout leach processes over long time periods. The test methods included three types of leach tests–the American Nuclear Society (ANS) 16.1 intermittent solution exchange test, a static leach test, and a once-through flow column test. The synthetic CRW used in the tests was prepared in five batches using simulated liquid waste spiked with several radionuclides: iodine (^{125}I), carbon (^{14}C), technetium (^{99}Tc), cesium (^{137}Cs), strontium (^{85}Sr), americium (^{241}Am), and plutonium (^{238}Pu). The grout was formed by mixing the simulated liquid waste with dry blend containing Type I and Type II Portland cement, class F fly ash, Indian Red Pottery clay, and calcium hydroxide. The mixture was allowed to set and cure at room temperature in closed containers for at least 46 days before it was tested.

28947 (PNL–10746) **Evaluation of the single-pass flow-through test to support a low-activity waste specification.** McGrail, B.P. (Pacific Northwest Lab., Richland, WA (United States)); Peeler, D.K. Pacific Northwest Lab., Richland, WA (United States). Sep 1995. 40p. Sponsored by USDOE, Washington, DC (United States). DOE Contract AC06-76RL01830. Order Number DE96000197. Source: OSTI; NTIS; INIS; GPO Dep.

A series of single-pass flow-through (SPFT) tests was performed on five reference low-activity waste glasses and a reference glass from the National Institute of Standards and Technology to support a product specification for low-activity waste (LAW) forms. The results showed that the SPFT test provides a means to quantitatively distinguish among LAW glass forms in terms of their forward reaction rate at a given temperature and solution pH. Two of the test glasses were also subjected to SPFT testing at Argonne National Laboratory (ANL). Forward reaction rate constants calculated from the ANL test data were 100 to over 1,000 times larger than the values obtained from the SPFT tests conducted at PNL. An analysis of the ANL results showed that they were inconsistent with independent measurements done on glasses of similar composition, the known pH-dependence of the forward rate, and with the results from low surface-area-to-volume, short duration product consistency tests. Because the data set obtained from the SPFT tests done at PNL was consistent with each of these same factors, a detailed examination of the test procedures used at both laboratories was performed to determine the cause(s) of the discrepancy. The omission of background subtraction in the data analysis procedure and the short-duration (on the order of hours) of the ANL tests are factors that may have significantly affected the calculated rates.

28948 (PNL–10754) **Sedimentation models.** Rector, D.R.; Bunker, B.C. Pacific Northwest Lab., Richland, WA (United States). Sep 1995. 30p. Sponsored by USDOE, Washington, DC (United States). DOE Contract AC06-76RL01830. Order Number DE96000748. Source: OSTI; NTIS; INIS; GPO Dep.

The nuclear wastes currently stored in tanks at the Hanford site contain complex mixtures of insoluble sludge particles, salts, and supernatant liquids. Treatment and ultimate disposal of these tank wastes will require that the complex solid-liquid mixtures be dispersed in aqueous solutions for retrieval and transport. The mixtures will then require pretreatment steps that will ultimately require the isolation of insoluble particles from supernatant liquids via solid-liquid separation steps such as settle-decant operations, centrifugation, or filtration. There is a perception that sludge treatment in general, and solid-liquid separations in particular, are relatively trivial operations that can easily be transferred to private industry to initiate tank cleanup. Experiences gained over the past few years at Hanford suggest that waste processing is not as trivial as it seems.

28949 (PNL–10755) **A survey and description of candidate technologies to support single shell tank waste retrieval, leak detection, monitoring, and mitigation.** Lewis, R.E.; Teel, S.S.; Wegener, W.H.; Iwatate, D.F. Pacific Northwest Lab., Richland, WA (United States). Sep 1995. 40p. Sponsored by USDOE, Washington, DC (United States). DOE Contract AC06-76RL01830. Order Number DE96000727. Source: OSTI; NTIS; INIS; GPO Dep.

This report was initially designed to provide a comprehensive review of potential leak detection technologies (LDTs). To this end, the report would contain several sections outlining the selection process. The purpose was twofold:(l) the reader would have a clear understanding of why specific technologies were recommended or not recommended, and (2) the reader could apply the same process in the future as new LDTs become available. Curtailment of project scope has prevented the development of the

requisite judging criteria. The report has been modified accordingly. Section 2 of this report presents the baseline and guiding assumptions that were used to judge the LDTs. These assumptions include the environment where the technologies would be employed, the potential leak detection targets, and anticipated leak mechanisms. Section 3 presents a brief review of the methods used to arrive at the recommended LDTs. It also includes a description of the different technology families considered. Section 4 presents the recommended LDTs along with detailed descriptions of each that include sensitivities, operating parameters, and costs.

28950 (PNL–10761) **Effect of colloidal aggregation on the sedimentation and rheological properties of tank waste.** Rector, D.R.; Bunker, B.C. Pacific Northwest Lab., Richland, WA (United States). Sep 1995. 60p. Sponsored by USDOE, Washington, DC (United States). DOE Contract AC06-76RL01830. Order Number DE96000745. Source: OSTI; NTIS; INIS; GPO Dep.

Tank farm experience and work performed under the Tank Waste Treatment Science task of the Tank Waste Remediation System (TWRS) Pretreatment Technology Development Project indicate that colloidal interactions can have an enormous impact on tank waste processing. This report provides the theoretical and experimental background required to understand how such agglomeration phenomena control the sedimentation and theological behavior of colloidal tank wastes. First, the report describes the conditions under which the colloidal particles present in tank sludge are expected to aggregate. Computational models have been developed to predict solution conditions leading to agglomeration, and to predict the rate and size of aggregate growth. The models show that tank sludge should be heavily agglomerated under most baseline processing conditions. Second, the report describes models used to predict sedimentation rates and equilibrium sediment density profiles based on knowledge of agglomerate structures. The sedimentation models provide a self-consistent picture that explains the apparent discrepancies between bench-top experiments and tank-farm experience. Finally, both discrete and empirical models are presented that can be used to rationalize and predict the rheological properties of colloidal sludge suspensions. In all cases, model predictions are compared and contrasted with experimental results. The net results indicate that most of the observed behaviors of real sludges can be predicted, understood, and perhaps ultimately controlled by understanding a few key central concepts regarding agglomeration phenomena.

28951 (PNL–10762) **Tank Waste Treatment Science Task quarterly report for October–December 1994.** LaFemina, J.P. (and others); Anderson, G.S.; Blanchard, D.L. Pacific Northwest Lab., Richland, WA (United States). Jan 1995. 40p. Sponsored by USDOE, Washington, DC (United States). DOE Contract AC06-76RL01830. Order Number DE96000732. Source: OSTI; NTIS; GPO Dep.

The Pretreatment Technology Development Project is one of seven Tank Waste Remediation System (TWRS) projects being conducted at Pacific Northwest Laboratory (PNL). A key objective of this project, which includes the Tank Waste Treatment Science Task, is to provide the technical basis and scientific understanding to support TWRS baseline decisions and actions, in particular, the 1998 sludge pretreatment decision regarding the level of pretreatment to be incorporated into the tank waste process flowsheets being developed by Westinghouse Hanford Company. This report details work performed by the Tank Waste Treatment Science Task during the first quarter of FY 1995 (October–December 1994) in support of the project objective. Specific activities discussed in the main text are: analytical methods development; sludge dissolution modeling; sludge characterization studies; sludge component speciation; pretreatment chemistry evaluation; and colloidal studies for solid-liquid separations.

28952 (PNL–10763) **Tank Waste Treatment Science Task quarterly report for January–March 1995.** LaFemina, J.P.; Anderson, G.S.; Blanchard, D.L. Pacific Northwest Lab., Richland, WA (United States). Apr 1995. 60p. Sponsored by USDOE, Washington, DC (United States). DOE Contract AC06-76RL01830. Order Number DE96000728. Source: OSTI; NTIS; GPO Dep.

The pretreatment Technology Development Project is one of seven Tank Waste Remediation (TWRS) System projects being conducted at the Pacific Northwest Laboratory. A key objective of this Project, and of the Tank Waste Treatment Science Task within it, is to provide the technical basis and scientific understanding to support TWRS baseline decisions and actions; in particular, TPA Milestone M50-03, the 1998 sludge pretreatment decision regarding the level of pretreatment to be incorporated into the tank waste process flowsheets. Work performed by this task during the second quarter of FY 1995 (January–March 1995) is detailed in this report. Work for the first quarter reported in Tank Waste Treatment Science Task, Quarterly Report for October–December 1994.

28953 (PNL–10765) **Removal of strontium and transuranics from Hanford waste via hydrothermal processing – FY 1994/95 test results.** Orth, R.J. (Pacific Northwest Lab., Richland, WA (United States)); Schmidt, A.J.; Elmore, M.R.; Hart, T.R.; Neuenschwander, G.G.; Gano, S.R.; Lehmann, R.W.; Momont, J.A. Pacific Northwest Lab., Richland, WA (United States). Sep 1995. 90p. Sponsored by USDOE, Washington, DC (United States). DOE Contract AC06-76RL01830. Order Number DE96000729. Source: OSTI; NTIS; INIS; GPO Dep.

Under the Tank Waste Remediation System (TWRS) Pretreatment Technology Development Project, Pacific Northwest Laboratory (PNL) is evaluating and developing organic destruction technologies that may be incorporated into the Initial Pretreatment Module (IPM) to treat Hanford tank waste. Organic (and ferrocyanide) destruction removes the compounds responsible for waste safety issues, and conditions the supernatant for low-level waste disposal by removing compounds that may be responsible for promoting strontium and transuranic (TRU) components solubility. Destruction or defunctionalization of complexing organics in tank wastes eliminates organic species that can reduce the efficiency of radionuclide (E.g., ^{90}Sr) separation processes, such as ion exchange, solvent extraction, and precipitation. The technologies being evaluated and tested for organic destruction are low-temperature hydrothermal processing (HTP) and wet air oxidation (WAO). Four activities are described: Batch HTP/WAO testing with Actual Tank Waste (Section 3.0), Batch HTP Testing with Simulant (Section 4.0), Batch WAO testing with Simulant (Section 5.0), and Continuous Bench-scale WAO Testing with Simulant (Section 6.0). For each of these activities, the objectives, test approach, results, status, and direction of future investigations are discussed. The background and history of the HTP/WAO technology is summarized below. Conclusions and Recommendations are provided in Section 2.0. A continuous HTP off-gas safety evaluation conducted in FY 1994 is included as Appendix A.

28954 (PNL–10766) **Removal of strontium and transuranics from Hanford tank waste via addition of metal cations and chemical oxidant: FY 1995 test results.** Orth, R.J.; Zacher, A.H.; Schmidt, A.J.; Elmore, M.R.; Elliott, K.R.; Neuenschwander, G.G.; Gano, S.R. Pacific Northwest Lab., Richland, WA (United States). Sep 1995. 50p. Sponsored by USDOE, Washington, DC (United States). DOE Contract AC06-76RL01830. Order Number DE96000714. Source: OSTI; NTIS; INIS; GPO Dep.

Chelating organics and some of their degradation products in the Hanford tank waste, such as EDTA, HEDTA, and NTA act to solubilize strontium and transuranics (TRU) in the tank waste supernatant. Displacement of strontium and TRU will facilitate the removal of these radionuclides via precipitation/filtration, ion exchange, or solvent extraction so that low-level waste feed specifications can be met. Pacific Northwest Laboratory has investigated two methods for releasing organic-complexed strontium and TRU components to allow for effective pretreatment of tank waste supernatant: metal cation addition (to promote displacement and flocculation) and chemical oxidant (pennanganate) addition (to promote chelator destruction/defunctionalization and possibly flocculation). These methods, which can be conducted at near-ambient. temperatures and pressures, could be deployed as intank processes.

28955 (PNL–10777) **Advanced organic analysis and analytical methods development: FY 1995 progress report. Waste Tank Organic Safety Program.** Wahl, K.L. (and others); Campbell, J.A.; Clauss, S.A. Pacific Northwest Lab., Richland, WA

(United States). Sep 1995. 70p. Sponsored by USDOE, Washington, DC (United States). DOE Contract AC06-76RL01830. Order Number DE96000731. Source: OSTI; NTIS; INIS; GPO Dep.

This report describes the work performed during FY 1995 by Pacific Northwest Laboratory in developing and optimizing analysis techniques for identifying organics present in Hanford waste tanks. The main focus was to provide a means for rapidly obtaining the most useful information concerning the organics present in tank waste, with minimal sample handling and with minimal waste generation. One major focus has been to optimize analytical methods for organic speciation. Select methods, such as atmospheric pressure chemical ionization mass spectrometry and matrix-assisted laser desorption/ionization mass spectrometry, were developed to increase the speciation capabilities, while minimizing sample handling. A capillary electrophoresis method was developed to improve separation capabilities while minimizing additional waste generation. In addition, considerable emphasis has been placed on developing a rapid screening tool, based on Raman and infrared spectroscopy, for determining organic functional group content when complete organic speciation is not required. This capability would allow for a cost-effective means to screen the waste tanks to identify tanks that require more specialized and complete organic speciation to determine tank safety.

28956 (PNL–10781) **The effect of dilution on the gas-retention behavior of Tank 241-SY-101 waste.** Bredt, P.R.; Tingey, S.M.; Shade, E.H. Pacific Northwest Lab., Richland, WA (United States). Sep 1995. 19p. Sponsored by USDOE, Washington, DC (United States). DOE Contract AC06-76RL01830. Order Number DE96000747. Source: OSTI; NTIS; INIS; GPO Dep.

The effect of dilution on gas retention in waste from Tank 241-SY-101 was investigated. A composite sample was prepared from material collected during the Window "C" and Window "E" sampling events. The composite contained material from both the convective and nonconvective layer in the proportions existing in the tank. Operation of the mixer pump in Tank 241-SY-101 has homogenized the tank material, and dilution of the current waste would require additional mixing; therefore, no attempt was made to use unhomogenized tank waste to prepare the composite. The composite was diluted with 2 M NaOH at ratios of 0.5:1, 0.75: 1, 1:1, and 3:1 per volume (2 M NaOH:tank waste).

28957 (PNL–10785) **Solubilities of gases in simulated Tank 241-SY-101 wastes.** Norton, J.D.; Pederson, L.R. Pacific Northwest Lab., Richland, WA (United States). Sep 1995. 35p. Sponsored by USDOE, Washington, DC (United States). DOE Contract AC06-76RL01830. Order Number DE96000713. Source: OSTI; NTIS; INIS; GPO Dep.

Oxygen, nitrogen, hydrogen, methane, and nitrous oxide solubilities were evaluated as a function of temperature in SYI-SIM-93B, a homogeneous simulated waste mixture containing sodium hydroxide, sodium nitrite, sodium nitrate, sodium aluminate, and sodium carbonate, the principal inorganic constituents of the wastes in Tank 241-SY-101. Ammonia solubility data for this simulated waste was obtained as a function of temperature in an earlier study. The choice of a homogeneous waste mixture in this study has the advantage of eliminating complications associated with a changing electrolyte concentration as a function of temperature that would be encountered with a slurry simulant. Dissolution is one of the means by which gases may be retained in Hanford Site wastes. While models are available to estimate gas solubilities in electrolyte solutions, few data are in existence that pertain to highly concentrated, multicomponent electrolytes such as those stored in Hanford Site waste tanks.

28958 (PNL–10788) **The role of plants and animals in isolation barriers at Hanford, Washington.** Link, S.O.; Cadwell, L.L.; Petersen, K.L.; Sackschewsky, M.R.; Landeen, D.S. Pacific Northwest Lab., Richland, WA (United States). Sep 1995. 60p. Sponsored by USDOE, Washington, DC (United States). DOE Contract AC06-76RL01830. Order Number DE96000814. Source: OSTI; NTIS; INIS; GPO Dep.

The Hanford Site Surface Barrier Development Program was organized in 1985 to test the effectiveness of various barrier designs in minimizing the effects of water infiltration; plant, animal, and human intrusion; and wind and water erosion on buried wastes, and in minimizing the emanation of noxious gases. Plants will serve to minimize drainage and erosion, but present,the potential for growing roots into wastes. Animals burrow holes into the soil, and the burrow holes could allow water to preferentially drain into the waste. They also bring soil to the surface which, if wastes are incorporated, could present a risk for the dispersion of wastes into the environment. This report reviews work done to assess the role of plants and animals in isolation barriers at Hanford. It also reviews work done to understand the potential effects from climate change on the plants and animals that may inhabit barriers in the future.

28959 (PNL–10792) **Ion exchange removal of cesium from simulated and actual supernate from Hanford tanks 241-SY-101 and 241-SY-103.** Brown, G.N. (and others); Bontha, J.R.; Carlson, C.D. Pacific Northwest Lab., Richland, WA (United States). Sep 1995. 50p. Sponsored by USDOE, Washington, DC (United States). DOE Contract AC06-76RL01830. Order Number DE96000818. Source: OSTI; NTIS; INIS; GPO Dep.

Pacific Northwest Laboratory (PNL), in conjunction with the Process Chemistry and Statistics Section of Westinghouse Hanford Company (WHC), conducted this study as part of the Supernatant Treatment Development Task for the Initial Pretreatment Module (IPM) Applied Engineering Project. The study assesses the performance of the CS-100 ion exchange material for removing cesium from simulated and actual alkaline supernate from Hanford tanks 241-SY-101 and 241-SY-103. The objective of these experiments is to compare the cesium ion exchange loading and elution profiles of actual and simulated wastes. Specific experimental objectives include (1) demonstration of decontamination factors (DF) for cesium removal, 92) verification of simulant performance, (3) investigation of waste/exchanger chemistry, and (4) determination of the radionuclide content of the regenerated CS-100 resin prior to disposal.

28960 (PNL–10815) **Dilution physics modeling: Dissolution/precipitation chemistry.** Onishi, Y.; Reid, H.C.; Trent, D.S. Pacific Northwest Lab., Richland, WA (United States). Sep 1995. 40p. Sponsored by USDOE, Washington, DC (United States). DOE Contract AC06-76RL01830. Order Number DE96000813. Source: OSTI; NTIS; INIS; GPO Dep.

This report documents progress made to date on integrating dilution/precipitation chemistry and new physical models into the TEMPEST thermal-hydraulics computer code. Implementation of dissolution/precipitation chemistry models is necessary for predicting nonhomogeneous, time-dependent, physical/chemical behavior of tank wastes with and without a variety of possible engineered remediation and mitigation activities. Such behavior includes chemical reactions, gas retention, solids resuspension, solids dissolution and generation, solids settling/rising, and convective motion of physical and chemical species. Thus this model development is important from the standpoint of predicting the consequences of various engineered activities, such as mitigation by dilution, retrieval, or pretreatment, that can affect safe operations. The integration of a dissolution/precipitation chemistry module allows the various phase species concentrations to enter into the physical calculations that affect the TEMPEST hydrodynamic flow calculations. The yield strength model of non-Newtonian sludge correlates yield to a power function of solids concentration. Likewise, shear stress is concentration-dependent, and the dissolution/precipitation chemistry calculations develop the species concentration evolution that produces fluid flow resistance changes. Dilution of waste with pure water, molar concentrations of sodium hydroxide, and other chemical streams can be analyzed for the reactive species changes and hydrodynamic flow characteristics.

28961 (PNL-SA–25207) **The comparison of element partitioning in two types of thermal treatment facilities and the effects on potential radiation dose.** Aaberg, R.L. (Pacific Northwest Lab., Richland, WA (United States)); Burger, L.L.; Baker, D.A.; Wallo, A. III; Vazquez, G.A.; Beck, W.L. Pacific Northwest Lab., Richland, WA (United States). May 1995. 10p. Sponsored by USDOE, Washington, DC (United States). DOE Contract AC06-76RL01830. (CONF-950542–4: 14. international symposium on thermal treatment technologies: incineration conference, Seattle, WA (United States), 8-12 May 1995). Order Number DE95014175. Source: OSTI; NTIS; INIS; GPO Dep.

The US Department of Energy (DOE) is performing a technical analysis to support the potential development of risk-based, numerical radiological control criteria (RCC) for mixed waste from DOE operations. As part of the technical analysis, potential future radiation doses are being calculated for workers at thermal treatment facilities and members of the public residing near such facilities. This study compared two types of thermal treatment systems: a conventional combustion chamber with excess air, represented by a rotary kiln with afterburner, and an oxygen-deficient pyrolysis unit, represented by a plasma arc furnace. The purpose of the first part of this study is to estimate the partitioning for significant radionuclides and elements in the two types of thermal treatment systems. Excess-air systems are generally found to produce heavy-metal chlorides, oxides, and sulfates; plasma-arc systems tend to produce more volatile free metals. This difference causes a change in source term dominance from halide volatility to free metal volatility. Chemical thermodynamic methodology is used to estimate partitioning in the two treatment systems. The second part of the study examines how the potential radiation dose to workers handling residue materials is affected by partitioning of radionuclides at the different types of facilities.

28962 (PNL-SA–25595) **Theory and numerical application of subsurface flow and transport for transient freezing conditions.** White, M.D. (Pacific Northwest Lab., Richland, WA (United States). Earth and Environmental Sciences Center). Pacific Northwest Lab., Richland, WA (United States). Apr 1995. 10p. Sponsored by USDOE, Washington, DC (United States). DOE Contract AC06-76RL01830. (CONF-9504192–1: 15. annual hydrology days conference, Ft. Collins, CO (United States), 3-7 Apr 1995). Order Number DE95014182. Source: OSTI; NTIS; INIS; GPO Dep.

Protective barriers are being investigated for the containment of radioactive waste within subsurface environments. Predicting the effectiveness of cryogenic barriers and near-surface barriers in temperate or arctic climates requires capabilities for numerically modeling subsurface flow and transport for freezing soil conditions. A predictive numerical model is developed herein to simulate the flow and transport of radioactive solutes for three-phase (water-ice-air) systems under freezing conditions. This physically based model simulates the simultaneous flow of water, air, heat, and radioactive solutes through variably saturated and variably frozen geologic media. Expressions for ice (frozen water) and liquid water saturations as functions of temperature, interfacial pressure differences, and osmotic potential are developed from nonhysteretic versions of the Brooks and Corey and van Genuchten functions for soil moisture retention. Aqueous relative permeability functions for variably saturated and variably frozen geologic media are developed from the Mualem and Burdine theories for predicting relative permeability of unsaturated soil. Soil deformations, caused by freezing and melting transitions, are neglected. Algorithms developed for predicting ice and liquid water saturations and aqueous-phase permeabilities were incorporated into the finite-difference based numerical simulator STOMP (Subsurface Transport Over Multiple Phases). Application of the theory is demonstrated by the solution of heat and mass transport in a horizontal cylinder of partially saturated porous media with differentially cooled ends, with the colder end held below the liquid water freezing point. This problem represents an essential capability for modeling cryogenic barriers in variably saturated geologic media.

28963 (PNL-SA–26402) **Overview of contamination from US and Russian nuclear complexes.** Bradley, D.J. Pacific Northwest Lab., Richland, WA (United States). Jun 1995. 24p. Sponsored by USDOE, Washington, DC (United States). DOE Contract AC06-76RL01830. (CONF-9506245–1: NATO meeting on nuclear submarine decommissioning and related problems, Moscow (Russian Federation), 19-22 Jun 1995). Order Number DE95016818. Source: OSTI; NTIS; INIS; GPO Dep.

This paper briefly compares the United States and Russian weapons complexes and provides a perspective on the releases of radioactivity to the environment in both countries. Fortunately, the technologies, data, models, and scientific experience that have been gained over the last 50 years are being shared between the US Department of Energy (DOE) and Ministry of Atomic Energy of the Russian Federation (MINATOM) which constitutes a new environmental partnership between the two countries.

28964 (SAND–93-7111) **Thermomechanical damage recovery parameters for rocksalt from the Waste Isolation Pilot Plant.** Brodsky, N.S. (RE/SPEC, Inc., Rapid City, SD (United States)). Sandia National Labs., Albuquerque, NM (United States). Aug 1995. 55p. Sponsored by USDOE, Washington, DC (United States). DOE Contract AC04-94AL85000. Order Number DE95017546. Source: OSTI; NTIS; INIS; GPO Dep.

Laboratory tests were conducted in which intact WIPP salt specimens were damaged by testing under constant strain-rate triaxial conditions at low confining pressure (0.5 MPa) and near room temperature (25°C) until 1.5 percent axial strain was reached. Introduction of dilatant damage caused specimen volume to increase and compressional wave velocities and amplitudes to decrease. Specimens were then subjected to hydrostatic loads of 15 MPa at a temperature of either 20°C, 46°C, or 70°C. Under these conditions damage was partially recovered and specimen volume and compressional wave characteristics approached the values of the undamaged state. The data from each test were fitted using a first order kinetics law to determine characteristic time constants for the damage recovery process at each temperature. The mean time constant associated with recovery of ultrasonic amplitudes decreased as temperature increased, as expected for a thermally activated process. Time constants associated with ultrasonic velocities and with volumetric strains showed no systematic change with temperature. The modeling results show that time constants are very short compared with time scales required for creep closure of rooms and shafts, implying that the rate of healing under confining pressure will be extremely rapid. The rates of volumetric strain recovery determined at different temperatures were fitted to an Arrhenius plot to determine an activation energy for the recovery process. The data were fitted using linear least squares to calculate an activation energy of 10.5 $kJ \cdot mole^{-1}$.

28965 (SAND–94-0244) **Stochastic hydrogeologic units and hydrogeologic properties development for total-system performance assessments. Yucca Mountain Site Characterization Project.** Schenker, A.R. (Los Alamos Technical Associates, Albuquerque, NM (United States)); Guerin, D.C.; Robey, T.H.; Rautman, C.A.; Barnard, R.W. Sandia National Labs., Albuquerque, NM (United States). Sep 1995. 150p. Sponsored by USDOE, Washington, DC (United States). DOE Contract AC04-94AL85000. Order Number DE96000699. Source: OSTI; NTIS; INIS; GPO Dep.

A stochastic representation of the lithologic units and associated hydrogeologic parameters of the potential high-level nuclear waste repository are developed for use in performance-assessment calculations, including the Total-System Performance Assessment for Yucca Mountain-SNL Second Iteration (TSPA-1993). A simplified lithologic model has been developed based on the physical characteristics of the welded and nonwelded units at Yucca Mountain. Ten hydrogeologic units are developed from site-specific data (lithologic and geophysical logs and core photographs) obtained from the unsaturated and saturated zones. The three-dimensional geostatistical model of the ten hydrogeologic units is based on indicator-coding techniques and improves on the two-dimensional model developed for TSPA91. The hydrogeologic properties (statistics and probability distribution functions) are developed from the results of laboratory tests and in-situ aquifer tests or are derived through fundamental relationships. Hydrogeologic properties for matrix properties, bulk conductivities, and fractures are developed from existing site specific data. Extensive data are available for matrix porosity, bulk density, and matrix saturated conductivity. For other hydrogeologic properties, the data are minimal or nonexistent. Parameters for the properties are developed as beta probability distribution functions. For the model units without enough data for analysis, parameters are developed as analogs to existing units. A relational, analytic approach coupled with bulk conductivity parameters is used to develop fracture parameters based on the smooth-wall-parallel-plate theory. An analytic method is introduced for scaling small-core matrix properties to the hydrogeologic unit scales.

28966 (SAND–94-0437) **SURFSCAN: Program to operate a LASER profilometer. Yucca Mountain Site Characterization Project.** Hardy, R.D. Sandia National Labs., Albuquerque, NM

(United States). Sep 1995. 72p. Sponsored by USDOE, Washington, DC (United States). DOE Contract AC04-94AL85000. Order Number DE96000207. Source: OSTI; NTIS; INIS; GPO Dep.

This paper is written to document the SURFSCAN program. A large section of the code is devoted to error recovery. The heavy emphasis on error recovery allows unattended operation for extended periods. By combining error recovery with the use of control files, SURFSCAN has been operated for periods of several days with no operator intervention. At this time, the Surface Profilometer is a useful and productive tool in the Rock Mechanics Laboratory at Sandia National Laboratories/New Mexico. In the Rock Mechanics Laboratory we have been conducting studies of the normal and shear mechanical behavior of fractures and the flow of fluid through fractured rock formations. To estimate these properties, we need to know the average aperture size and surface texture of a fracture. These data may be obtained from surface profiles of mating pieces of rock. By scanning corresponding regions on two mating surfaces, the aperture size may be easily determined.

28967 (SAND–94-2217) **Accelerator Production of Tritium project process waste assessment.** Carson, S.D.; Peterson, P.K. Sandia National Labs., Albuquerque, NM (United States). Sep 1995. 122p. Sponsored by USDOE, Washington, DC (United States). DOE Contract AC04-94AL85000. Order Number DE96000692. Source: OSTI; NTIS; INIS; GPO Dep.

DOE has made a commitment to compliance with all applicable environmental regulatory requirements. In this respect, it is important to consider and design all tritium supply alternatives so that they can comply with these requirements. The management of waste is an integral part of this activity and it is therefore necessary to estimate the quantities and specific wastes that will be generated by all tritium supply alternatives. A thorough assessment of waste streams includes waste characterization, quantification, and the identification of treatment and disposal options. The waste assessment for APT has been covered in two reports. The first report was a process waste assessment (PWA) that identified and quantified waste streams associated with both target designs and fulfilled the requirements of APT Work Breakdown Structure (WBS) Item 5.5.2.1. This second report is an expanded version of the first that includes all of the data of the first report, plus an assessment of treatment and disposal options for each waste stream identified in the initial report. The latter information was initially planned to be issued as a separate Waste Treatment and Disposal Options Assessment Report (WBS Item 5.5.2.2).

28968 (SAND–95-0591) **Batch and column studies of adsorption of Li, Ni and Br by a reference sand for contaminant transport experiments.** Seigel, M.D. (Sandia National Labs., Albuquerque, NM (United States)); Ward, D.B.; Bryan, C.R. Sandia National Labs., Albuquerque, NM (United States): Sandia Labs., Livermore, CA (United States). Sep 1995. 200p Sponsored by USDOE, Washington, DC (United States). DOE Contract AC04-94AL85000 ; AC04-76DP00789. Order Number DE96001139. Source: OSTI; NTIS; INIS; GPO Dep.

A processed quartz sand (Wedron 510), mined from the St. Peter sandstone, has been characterized by a variety of chemical and physical methods for use as a reference porous media in transport model validation experiments. Wedron 510 sand was used in an intermediate-scale experiment involving migration of Ni, Li and Br through a 6-m high x 3-m diameter caisson. Ni and Li adsorption/desorption, and Li/Ni site-competition experiments yielded information on the importance of the trace mineral phases to adsorption of Li and Ni by the sand. The presence of an iron hydroxide coating similar to goethite on the sand grains is suggested by visual observation and leaching experiments. Kaolinite was identified by SEM and XRD as a significant trace mineral phase in the sand and occurs as small particles coating the sand grains. Quartz, the predominant constituent of the sand by weight, does not appear to contribute significantly to the adsorption properties of the sand. Qualitatively, the adsorption properties of the sand can be adequately modeled as a two-mineral system (goethite and kaolinite). The studies described in this report should provide a basis for understanding transport of Ni, Li and Br through porous media similar to the reference sand. Techniques were developed for obtaining parameter values for surface complexation and kinetic adsorption models for the sand and its mineral components. These constants can be used directly in coupled hydrogeochemical transport codes. The techniques should be useful for characterization of other natural materials and elements in high-level nuclear waste in support of coupled hydrogeochemical transport calculations for Yucca Mountain.

28969 (SAND–95-1461) **Geophysical characterization of subsurface barriers.** Borns, D.J. Sandia National Labs., Albuquerque, NM (United States). Aug 1995. 34p. Sponsored by USDOE, Washington, DC (United States). DOE Contract AC04-94AL85000. Order Number DE95016952. Source: OSTI; NTIS; INIS; GPO Dep.

An option for controlling contaminant migration from plumes and buried waste sites is to construct a subsurface barrier of a low-permeability material. The successful application of subsurface barriers requires processes to verify the emplacement and effectiveness of barrier and to monitor the performance of a barrier after emplacement. Non destructive and remote sensing techniques, such as geophysical methods, are possible technologies to address these needs. The changes in mechanical, hydrologic and chemical properties associated with the emplacement of an engineered barrier will affect geophysical properties such a seismic velocity, electrical conductivity, and dielectric constant. Also, the barrier, once emplaced and interacting with the in situ geologic system, may affect the paths along which electrical current flows in the subsurface. These changes in properties and processes facilitate the detection and monitoring of the barrier. The approaches to characterizing and monitoring engineered barriers can be divided between (1) methods that directly image the barrier using the contrasts in physical properties between the barrier and the host soil or rock and (2) methods that reflect flow processes around or through the barrier. For example, seismic methods that delineate the changes in density and stiffness associated with the barrier represents a direct imaging method. Electrical self potential methods and flow probes based on heat flow methods represent techniques that can delineate the flow path or flow processes around and through a barrier.

28970 (SAND–95-2244C) **Using a multiphase flow code to model the coupled effects of repository consolidation and multiphase brine and gas flow at the Waste Isolation Pilot Plant.** Freeze, G.A. (INTERA Inc., Albuquerque, NM (United States)); Larson, K.W.; Davies, P.B.; Webb, S.W. Sandia National Labs., Albuquerque, NM (United States). [1995]. 8p. Sponsored by USDOE, Washington, DC (United States). DOE Contract AC04-94AL85000. (CONF-950828–22: National heat transfer conference, Portland, OR (United States), 5-9 Aug 1995). Order Number DE96000704. Source: OSTI; NTIS; INIS; GPO Dep.

Long-term repository assessment must consider the processes of (1) gas generation, (2) room closure and expansions due to salt creep, and (3) multiphase (brine and gas) fluid flow, as well as the complex coupling between these three processes. The mechanical creep closure code SANCHO was used to simulate the closure of a single, perfectly sealed disposal room filled with water and backfill. SANCHO uses constitutive models to describe salt creep, waste consolidation, and backfill consolidation, Five different gas-generation rate histories were simulated, differentiated by a rate multiplier, f, which ranged from 0.0 (no gas generation) to 1.0 (expected gas generation under brine-dominated conditions). The results of the SANCHO f-series simulations provide a relationship between gas generation, room closure, and room pressure for a perfectly sealed room. Several methods for coupling this relationship with multiphase fluid flow into and out of a room were examined. Two of the methods are described.

28971 (S-HRG–95016366) **Radioactive and other environmental threats to the United States and the Arctic resulting from past Soviet activities.** USDOE, Washington, DC (United States). [1993]. 614p. Sponsored by United States Senate, Washington, DC (United States). Source: OSTI; NTIS; INIS; GPO.

Earlier this year the Senate Intelligence Committee began to receive reports from environmental and nuclear scientists in Russia detailing the reckless nuclear waste disposal practices, nuclear accidents and the use of nuclear detonations. We found that information disturbing to say the least. Also troubling is the fact that 15

Chernobyl style RBMK nuclear power reactors continue to operate in the former Soviet Union today. These reactors lack a containment structure and they're designed in such a way that nuclear reaction can actually increase when the reactor overheats. As scientists here at the University of Alaska have documented, polar air masses and prevailing weather patterns provide a pathway for radioactive contaminants from Eastern Europe and Western Russia, where many of these reactors are located. The threats presented by those potential radioactive risks are just a part of a larger Arctic pollution problem. Every day, industrial activities of the former Soviet Union continue to create pollutants. I think we should face up to the reality that in a country struggling for economic survival, environment protection isn't necessarily the high priority. And that could be very troubling news for the Arctic in the future.

28972 (UCRL-CR–122068) **Assessment of the effects of microbially influenced degradation on a massive concrete structure. Final report, Report 5.** Rogers, R.D. (Biodegradation Systems, Inc., Idaho Falls, ID (United States)). Lawrence Livermore National Lab., CA (United States); Biodegradation Systems, Inc., Idaho Falls, ID (United States). 8 Jul 1995. 96p. Sponsored by USDOE, Washington, DC (United States). DOE Contract W-7405-ENG-48. Order Number DE96000372. Source: OSTI; NTIS; INIS; GPO Dep.

There is a need to estimate the effect of environmental conditions on construction materials to be used in the repository at Yucca Mountain. Previous reports from this project have demonstrated that it is important to develop an understanding of microbially influenced degradation (MID) development and its influence on massive concrete structures. Further, it has been shown that the most effective way to obtain quantitative data on the effects of MID on the structural integrity of repository concrete is to study manmade, analog structures known to be susceptible to MID. The cooling tower shell located at the Ohaaki Power Station near Wairakei, New Zealand is such a structure.

28973 (UCRL-ID–116187-95-1) **The mixed waste management facility. Monthly report, January 1995.** Streit, R. Lawrence Livermore National Lab., CA (United States). Feb 1995. 49p. Sponsored by USDOE, Washington, DC (United States). DOE Contract W-7405-ENG-48. Order Number DE95017299. Source: OSTI; NTIS; GPO Dep.

During January, technical progress continued in general accordance with the MWMF FY95 Plan. Engineering development and design continued in support of preliminary design of MWMF major subsystems. Certain activities are being delayed due to DOE guidance for reduced funding profiles that would not warrant new hiring, early procurements, etc. Peer reviews and system preliminary design reviews are now being scheduled for project elements. We continued pursuing integration of MWMF and DWTF functions maximize cost savings. We also expended considerable engineering effort to provide technical and cost tradeoff information for the FY97 Validation. Management focus during January centered upon addressing the rebaseline for MWMF for FY97 Validation in March, and upon progressing with the RD&D permit. Funding baselines for preparing for FY97 Validation in March were obtained from DOE; based on the baseline, detailed scope, schedule, and budget guidance was issued to the project staff to develop Validation information. For reasons of cost-effectiveness, Validation cost estimates will be based on revised CDR estimates, since bottom-up estimates will be completed in July as part of Preliminary Design. We have directed Significant effort toward meeting the TPC and fiscal year profile costs while still maintaining the essential elements of the project. Final review and editorial changes were completed for the RD&D permit application. Based on the meeting with DTSC in December and revised operational requirements, we held a review of the overall permitting strategy prior to routing for signature approval. A simplified strategy is under review. The revised Environmental Assessment (EA) is ready for release to DOE, but is being held up pending results of the permitting strategy review.

28974 (UCRL-ID–116187-95-6) **The mixed waste management facility. Monthly report.** Streit, R.D. Lawrence Livermore National Lab., CA (United States). Jul 1995. 55p. Sponsored by USDOE, Washington, DC (United States). DOE Contract W-7405-ENG-48. Order Number DE95017302. Source: OSTI; NTIS; GPO Dep.

This report presents a project summary for the Mixed Waste Management facility from the Lawrence Livermore National Laboratory for June, 1995. Key developments were the installation of the MSO Engineering Development Unit (EDU) which is on schedule for operation in July, and the first preliminary design review. This report also describes budgets and includes a milestone log of activities.

28975 (UCRL-ID–119105) **The mixed waste management facility, FY95 plan.** Streit, R. Lawrence Livermore National Lab., CA (United States). Dec 1994. 66p. Sponsored by USDOE, Washington, DC (United States). DOE Contract W-7405-ENG-48. Order Number DE96001170. Source: OSTI; NTIS; GPO Dep.

This document contains the Fiscal Year 1995 Plan for the Mixed Waste Management Facility (MWMF) at Lawrence Livermore National Laboratory. Major objectives to be completed during FY 1995 for the MWMF project are listed and described. This report also contains a budget plan, project task summaries, a milestone control log, and a responsibility assignment matrix for the MWMF project.

28976 (UCRL-ID–119564-Vol.1) **Engineered materials characterization report for the Yucca Mountain Site Characterization Project. Volume 1, Introduction, history, and current candidates.** Van Konynenburg, R.A.; McCright, R.D.; Roy, A.K.; Jones, D.A. Lawrence Livermore National Lab., CA (United States). Aug 1995. 58p. Sponsored by USDOE, Washington, DC (United States). DOE Contract W-7405-ENG-48 ; AC01-91RW00134. Order Number DE96000369. Source: OSTI; NTIS; INIS; GPO Dep.

The purpose of the Yucca Mountain Site Characterization Project is to evaluate Yucca Mountain for its suitability as a potential site for the nation's first high-level nuclear waste repository. As part of this effort, Lawrence Livermore National Laboratory (LLNL) has been occupied for a number of years with developing and evaluating the performance of waste packages for the potential repository. In recent years this work has been carried out under the guidance of and in collaboration with the Management and Operating contractor for the Civilian Radioactive Waste Management System, TRW Environmental Safety Systems, Inc., which in turn reports to the Office of Civilian Radioactive Waste Management of the US Department of Energy. This report summarizes the history of the selection and characterization of materials to be used in the engineered barrier system for the potential repository at Yucca Mountain, describes the current candidate materials, presents a compilation of their properties, and summarizes available corrosion data and modeling. The term "engineered materials" is intended to distinguish those materials that are used as part of the engineered barrier system from the natural, geologic materials of the site.

28977 (UCRL-ID–119564-Vol.2) **Engineered materials characterization report for the Yucca Mountain Site Characterization Project. Volume 2, Design data.** Konynenburg, R.A. (Lawrence Livermore National Lab., CA (United States)); McCright, R.D.; Roy, A.K.; Jones, D.A. Lawrence Livermore National Lab., CA (United States). Aug 1995. 50p. Sponsored by USDOE, Washington, DC (United States). DOE Contract W-7405-ENG-48 ; AC01-91RW00134. Order Number DE96000370. Source: OSTI; NTIS; INIS; GPO Dep.

This is Volume 2 of the Engineered Materials Characterization Report which presents the design data for candidate materials needed in fabricating different components for both large and medium multi-purpose canister (MPC) disposal containers, waste packages for containing uncanistered spent fuel (UCF), and defense high-level waste (HLW) glass disposal containers. The UCF waste package consists of a disposal container with a basket therein. It is assumed that the waste packages will incorporate all-metallic multibarrier disposal containers to accommodate medium and large MPCs, ULCF, and HLW glass canisters. Unless otherwise specified, the disposal container designs incorporate an outer corrosion-allowance metal barrier over an inner corrosion-resistant metal barrier. The corrosion-allowance barrier, which will be thicker than the inner corrosion-resistant barrier, is designed to undergo corrosion-induced degradation at a very low rate, thus providing

the inner barrier protection from the near-field environment for a prolonged service period.

28978 (UCRL-ID–119564-vol.3) **Engineered materials characterization report for the Yucca Mountain Site Characterization Project. Volume 3: Corrosion and data modeling.** Van Konynenburg, R.A. (Lawrence Livermore National Lab., CA (United States)); McCright, R.D.; Roy, A.K.; Jones, D.A. Lawrence Livermore National Lab., CA (United States). Aug 1995. 14p. Sponsored by USDOE, Washington, DC (United States). DOE Contract W-7405-ENG-48 ; AC01-91RW00134. Order Number DE96000371. Source: OSTI; NTIS; INIS; GPO Dep.

This three-volume report serves several purposes. The first volume provides an introduction to the engineered materials effort for the Yucca Mountain Site Characterization Project. It defines terms and outlines the history of selection and characterization of these materials. A summary of the recent engineered barrier materials characterization workshop is presented, and the current candidate materials are listed. The second volume tabulates design data for engineered materials, and the third volume is devoted to corrosion data, radiation effects on corrosion, and corrosion modeling. The second and third volumes are intended to be evolving documents, to which new data will be added as they become available from additional studies. The initial version of Volume 3 is devoted to information currently available for environments most similar to those expected in the potential Yucca Mountain repository. This is volume three.

28979 (UCRL-ID–119842) **Geothermal areas as analogues to chemical processes in the near-field and altered zone of the potential Yucca Mountain, Nevada repository.** Bruton, C.J.; Glassley, W.E.; Meike, A. Lawrence Livermore National Lab., CA (United States). Feb 1995. 24p. Sponsored by USDOE, Washington, DC (United States). DOE Contract W-7405-ENG-48. Order Number DE95017857. Source: OSTI; NTIS; INIS; GPO Dep.

The need to bound system performance of the potential Yucca Mountain repository for thousands of years after emplacement of high-level nuclear waste requires the use of computer codes. The use of such codes to produce reliable bounds over such long time periods must be tested using long-lived natural and historical systems as analogues. The geothermal systems of the Taupo Volcanic Zone (TVZ) in New Zealand were selected as the site most amenable to study. The rocks of the TVZ are silicic volcanics that are similar in composition to Yucca Mountain. The area has been subjected to temperatures of 25 to 300 C which have produced a variety of secondary minerals similar to those anticipated at Yucca Mountain. The availability of rocks, fluids and fabricated materials for sampling is excellent because of widespread exploitation of the systems for geothermal power. Current work has focused on testing the ability of the EQ3/6 code and thermodynamic data base to describe mineral-fluid relations at elevated temperatures. Welfare starting long-term dissolution/corrosion tests of rocks, minerals and manufactured materials in natural thermal features in order to compare laboratory rates with field-derived rates. Available field data on rates of silica precipitation from heated fluids have been analyzed and compared to laboratory rates. New sets of precipitation experiments are being planned. The microbially influenced degradation of concrete in the Broadlands-Ohaaki geothermal field is being characterized. The authors will continue to work on these projects in FY 1996 and expand to include the study of naturally occurring uranium and thorium series radionuclides, as a prelude to studying radionuclide migration in heated silicic volcanic rocks. 32 refs.

28980 (UCRL-ID–120523) **Preliminary 2D design study for A&PCT.** Keto, E. (and others); Azevedo, S.; Roberson, P. Lawrence Livermore National Lab., CA (United States). Mar 1995. 16p. Sponsored by USDOE, Washington, DC (United States). DOE Contract W-7405-ENG-48. Order Number DE96000353. Source: OSTI; NTIS; INIS; GPO Dep.

Lawrence Livermore National Laboratory is currently designing and constructing a tomographic scanner to obtain the most accurate possible assays of radioactivity in barrels of nuclear waste in a limited amount of time. This study demonstrates a method to explore different designs using laboratory experiments and numerical simulations. In particular, we examine the trade-off between spatial resolution and signal-to-noise. The simulations are conducted in two dimensions as a preliminary study for three dimensional imaging. We find that the optimal design is entirely dependent on the expected source sizes and activities. For nuclear waste barrels, preliminary results indicate that collimators with widths of 1 to 3 inch and aspect ratios of 5:1 to 10:1 should perform well. This type of study will be repeated in 3D in more detail to optimize the final design.

28981 (UCRL-ID–122058) **Analysis of DOE international environmental management activities.** Ragaini, R.C. Lawrence Livermore National Lab., CA (United States). Sep 1995. 30p. Sponsored by USDOE, Washington, DC (United States). DOE Contract W-7405-ENG-48. Order Number DE96000195. Source: OSTI; NTIS; GPO Dep.

The Department of Energy's (DOE) Strategic Plan (April 1994) states that DOE's long-term vision includes world leadership in environmental restoration and waste management activities. The activities of the DOE Office of Environmental Management (EM) can play a key role in DOE's goals of maintaining U.S. global competitiveness and ensuring the continuation of a world class science and technology community. DOE's interest in attaining these goals stems partly from its participation in organizations like the Trade Policy Coordinating Committee (TPCC), with its National Environmental Export Promotion Strategy, which seeks to strengthen U.S. competitiveness and the building of public-private partnerships as part of U.S. industrial policy. The International Interactions Field Office task will build a communication network which will facilitate the efficient and effective communication between DOE Headquarters, Field Offices, and contractors. Under this network, Headquarters will provide the Field Offices with information on the Administration's policies and activities (such as the DOE Strategic Plan), interagency activities, as well as relevant information from other field offices. Lawrence Livermore National Laboratory (LLNL) will, in turn, provide Headquarters with information on various international activities which, when appropriate, will be included in reports to groups like the TPCC and the EM Focus Areas. This task provides for the collection, review, and analysis of information on the more significant international environmental restoration and waste management initiatives and activities which have been used or are being considered at LLNL. Information gathering will focus on efforts and accomplishments in meeting the challenges of providing timely and cost effective cleanup of its environmentally damaged sites and facilities, especially through international technical exchanges and/or the implementation of foreign-development technologies.

28982 (UCRL-JC–119891) **Disposition of surplus fissile materials via immobilization.** Gray, L.W. (Lawrence Livermore National Lab., CA (United States)); Kan, T.; Sutcliffe, W.G.; McKibben, J.M.; Danker, W. Lawrence Livermore National Lab., CA (United States). 23 Jul 1995. 8p. Sponsored by USDOE, Washington, DC (United States). DOE Contract W-7405-ENG-48. (CONF-950787–83: 36. annual meeting of the Institute for Nuclear Materials Management, Palm Desert, CA (United States), 9-12 Jul 1995). Order Number DE96000338. Source: OSTI; NTIS; INIS; GPO Dep.

In the Cold War aftermath, the US and Russia have agreed to large reductions in nuclear weapons. To aid in the selection of long-term management options, the USDOE has undertaken a multifaceted study to select options for storage and disposition of surplus plutonium (Pu). One disposition alternative being considered is immobilization. Immobilization is a process in which surplus Pu would be embedded in a suitable material to produce an appropriate form for ultimate disposal. To arrive at an appropriate form, we first reviewed published information on HLW immobilization technologies to identify forms to be prescreened. Surviving forms were screened using multi-attribute utility analysis to determine promising technologies for Pu immobilization. We further evaluated the most promising immobilization families to identify and seek solutions for chemical, chemical engineering, environmental, safety, and health problems; these problems remain to be solved before we can make technical decisions about the viability of using the forms for long-term disposition of Pu. All data, analyses, and reports are being provided to the DOE Office of Fissile Materials

Disposition to support the Record of Decision that is anticipated in Summer of 1996.

28983 (UCRL-JC–120141) **Direct chemical oxidation of hazardous and mixed wastes.** Cooper, J.F. (and others); Wang, F.; Farmer, J. Lawrence Livermore National Lab., CA (United States). 11 Apr 1995. 11p. Sponsored by USDOE, Washington, DC (United States). DOE Contract W-7405-ENG-48. (CONF-950877–17: 3. American Society for Mechanical Engineers biennial mixed waste symposium, Baltimore, MD (United States), 7-11 Aug 1995). Order Number DE95017293. Source: OSTI; NTIS; GPO Dep.

Direct Chemical Oxidation (DCO) refers to the use of continuously-regenerated peroxydisulfate (with possible hydrogen peroxide supplements) to effect total destruction of organic wastes in aqueous media. The process does not involve toxic catalysts or the cogeneration of secondary wastes. Peroxydisulfate ($S_2O_8^{-2}$) is one the strongest known chemical oxidants. It is routinely used in laboratory total carbon analyzers–uncatalyzed at 100°C, or catalyzed by UV, platinum or dissolved transition metal ions–and detects by oxidative destruction to 0.01 ppm levels. We report: (1) development of a waste treatment approach grounded in industrial electrolysis practice and in reaction rate data for Pt-initiated $S_2O_8^{-2}$ oxidation at 100°C; (2) tests of an electrochemical cell generating 1.5 N peroxydisulfate solutions; (3) lower-limit rate data for destruction of surrogates for chemical warfare agents and compounds with functional groups resisting oxidation; and (4) destruction of a Dowex® ion exchange resin, such as used in nuclear processing. This technique is particularly suited for applications in analytical laboratories or in manufacturing industries where the waste generation is low in volume, highly toxic or fugitive, or changing. The process may be tailored for destruction of very small to bulk quantities of chemical warfare agents.

28984 (UCRL-JC–120389) **Challenges in defining a radiologic and hydrologic source term for underground nuclear test centers, Nevada Test Site, Nye County, Nevada.** Smith, D.K. Lawrence Livermore National Lab., CA (United States). Jun 1995. 10p. Sponsored by USDOE, Washington, DC (United States). DOE Contract W-7405-ENG-48. (CONF-950868–3: Environmental remediation conference: committed to results, Denver, CO (United States), 13-18 Aug 1995). Order Number DE95015887. Source: OSTI; NTIS; INIS; GPO Dep.

The compilation of a radionuclide inventory for long-lived radioactive contaminants residual from nuclear testing provides a partial measure of the radiologic source term at the Nevada Test Site. The radiologic source term also includes potentially mobile short-lived radionuclides excluded from the inventory. The radiologic source term for tritium is known with accuracy and is equivalent to the hydrologic source term within the saturated zone. Definition of the total hydrologic source term for fission and activation products that have high activities for decades following underground testing involves knowledge and assumptions which are presently unavailable. Systematic investigation of the behavior of fission products, activation products and actinides under saturated or Partially saturated conditions is imperative to define a representative total hydrologic source term. This is particularly important given the heterogeneous distribution of radionuclides within testing centers. Data quality objectives which emphasize a combination of measurements and credible estimates of the hydrologic source term are a priority for near-field investigations at the Nevada Test Site.

28985 (UCRL-JC–120547) **Detecting leaks in hydrocarbon storage tanks using electrical resistance tomography.** Daily, W.; Ramirez, A.; LaBrecque, D.; Binley, A. Lawrence Livermore National Lab., CA (United States). 3 Apr 1995. 14p. Sponsored by USDOE, Washington, DC (United States). DOE Contract W-7405-ENG-48. (CONF-9511130–1: Frontiers '95, San Luis Obispo, CA (United States), Nov 1995). Order Number DE96000086. Source: OSTI; NTIS; GPO Dep.

Large volumes of hydrocarbons are stored worldwide in surface and underground tanks. It is well documented [1] that all too often these tanks are found to leak, resulting in not only a loss of stored inventory but, more importantly, contamination to soil and groundwater. Two field experiments are reported herein to evaluate the utility of electrical resistance tomography (ERT) for detecting and locating leaks as well as delineating any resulting plumes emanating from steel underground storage tanks (UST). Current leak detection methods for single shell tanks require careful inventory monitoring, usually from liquid level sensors within the tank, or placement of chemical sensors in the soil under and around the tank. Liquid level sensors can signal a leak but are limited in sensitivity and, of course, give no information about the location or the leak or the distribution of the resulting plume. External sensors are expensive to retrofit and must be very densely spaced to assure reliable detection, especially in heterogeneous soils. The rational for using subsurface tomography is that it may have none of these shortcomings.

28986 (UCRL-JC–121447) **Casks (computer analysis of storage casks): A microcomputer based analysis system for storage cask review.** Chen, T.F.; Mok, G.C.; Carlson, R.W. Lawrence Livermore National Lab., CA (United States). Aug 1995. 8p. Sponsored by USDOE, Washington, DC (United States). DOE Contract W-7405-ENG-48. (CONF-950740–98: Joint ASME/JSME pressure vessels and piping conference, Honolulu, HI (United States), 23-27 Jul 1995). Order Number DE96000418. Source: OSTI; NTIS; GPO Dep.

CASKS is a microcomputer based computer system developed by LLNL to assist the Nuclear Regulatory Commission in performing confirmatory analyses for licensing review of radioactive-material storage cask designs. The analysis programs of the CASKS computer system consist of four modules: the impact analysis module, the thermal analysis module, the thermally-induced stress analysis module, and the pressure-induced stress analysis module. CASKS uses a series of menus to coordinate input programs, cask analysis programs, output programs, data archive programs and databases, so the user is able to run the system in an interactive environment. This paper outlines the theoretical background on the impact analysis module and the yielding surface formulation. The close agreement between the CASKS analytical predictions and the results obtained form the two storage casks drop tests performed by SNL and by BNFL at Winfrith serves as the validation of the CASKS impact analysis module.

28987 (UCRL-JC–121685) **Sodium carbonate salt transport system.** Brummond, W. Lawrence Livermore National Lab., CA (United States). 12 Sep 1995. 7p. Sponsored by USDOE, Washington, DC (United States). DOE Contract W-7405-ENG-48. (CONF-9509233–1: California Polytechnic State University senior engineering class, ME428 industrial participation problem, San Luis Obispo, CA (United States), 21 Sep 1995). Order Number DE96001314. Source: OSTI; NTIS; GPO Dep.

A sodium carbonate salt transport system is required to support the Molten Salt Oxidation system being constructed at Lawrence Livermore National Laboratory. We are embarking on a project to create a national test bed for evaluating mixed waste destruction technologies. This project is called the Mixed Waste Management Facility. It is currently in the second phase of design and will be operational in 1998. One of the first technologies demonstrated in this facility is Molten Salt Oxidation. Molten Salt Oxidation is a thermal process that destroys the organic constituents of mixed and hazardous wastes. Sodium carbonate salt is heated in a reactor vessel to approximately 950°C. Organic wastes, along with oxidant air, are injected under the pool of molten salt. A catalytic reaction occurs converting the organics into CO_2 and water. Inorganic constituents in the salt such as metals, silica, alumina, and radionuclides remain captured in the salt. Chlorides in the waste feed are converted in the salt to sodium chloride. As these impurities build up in the salt, the salt must be recycled to remove them or else the reaction rate is reduced. Spent salt is periodically taken from the reactor and transported to a salt recycle system. In this system the molten salt is freeze-dried, dissolved in water, and filtered to remove the insoluble inorganics. The unconverted sodium carbonate is removed by fractional crystallization. This sodium carbonate is then dried and stored for future use in the reactors, eliminating a secondary waste stream. The remaining brine is disposed of as waste.

28988 (UCRL-JC–121922) **Selection of a management strategy for depleted uranium hexafluoride.** Patton, S.E.; Hanrahan, E.J.; Bradley, C.E. Lawrence Livermore National Lab., CA

(United States). 6 Sep 1995. 11p. Sponsored by USDOE, Washington, DC (United States). DOE Contract W-7405-ENG-48. (CONF-950976–1: 20. annual symposium of the Uranium Institute, London (United Kingdom), 6-8 Sep 1995). Order Number DE96000812. Source: OSTI; NTIS; INIS; GPO Dep.

A consequence of the uranium enrichment process used in the United States (US) is the accumulation of a significant amount of depleted uranium hexafluoride (UF_6). Currently, approximately 560,000 metric tons of the material are stored at three different sites. The US Department of Energy (DOE) has recently initiated a program to consider alternative strategies for the cost-effective and environmentally safe long-term management of this inventory of depleted UF_6. The program involves a technology and engineering assessment of proposed management options (use/reuse, conversion, storage, or disposal) and an analysis of the potential environmental impacts and life-cycle costs of alternative management strategies. The information obtained from the studies will be used by the DOE to select a preferred long-term management strategy. The selection and implementation of a management strategy will involve consideration of a number of important issues such as environmental, health, and safety effects; the balancing of risks versus costs in a context of reduced government spending; socioeconomic implications, including effects on the domestic and international uranium industry; the technical status of proposed uses or technologies; and public involvement in the decision making process. Because of its provisions for considering a wide range of relevant issues and involving the public, this program has become a model for future DOE materials disposition programs. This paper presents an overview of the Depleted Uranium Hexafluoride Management Program. Technical findings of the program to date are presented, and major issues involved in selecting and implementing a management strategy are discussed.

28989 (WHC-EP–0474-17) **Quarterly report on the Ferrocyanide Safety Program for the period ending June 30, 1995.** Meacham, J.E.; Cash, R.J.; Dukelow, G.T. Westinghouse Hanford Co., Richland, WA (United States). Jul 1995. 85p. Sponsored by USDOE, Washington, DC (United States). DOE Contract AC06-87RL10930. Order Number DE95017142. Source: OSTI; NTIS; INIS; GPO Dep.

This is the seventeenth quarterly report on the progress of activities addressing the Ferrocyanide Safety Issue associated with Hanford Site high-level radioactive waste tanks. Progress in the Ferrocyanide Safety Program is reviewed, including work addressing the six pans of Defense Nuclear Facilities Safety Board Recommendation 90-7 (FR 1990). All work activities are described in the revised program plan (DOE 1994b), and this report follows the same format presented there. A summary of the key events occurring this quarter is presented.

28990 (WHC-EP–0538-2) **Operational Environmental Monitoring Program Quality Assurance Project Plan.** Perkins, C.J. Westinghouse Hanford Co., Richland, WA (United States). Aug 1994. 43p. Sponsored by USDOE, Washington, DC (United States). DOE Contract AC06-87RL10930. Order Number DE95017143. Source: OSTI; NTIS; GPO Dep.

This Quality Assurance Project Plan addresses the quality assurance requirements for the activities associated with the preoperational and operational environmental monitoring performed by Westinghouse Hanford Company as it implements the Operational Environmental Monitoring program. This plan applies to all sampling and monitoring activities performed by Westinghouse Hanford Company in implementing the Operational Environmental Monitoring program at the Hanford Site.

28991 (WHC-EP–0573-3) **Westinghouse Hanford Company operational environmental monitoring annual report, calendar year 1994.** Schmidt, J.; Fassett, J.W.; Johnson, A.R.; Johnson, V.G.; Markes, B.M.; McKinney, S.M.; Moss, K.J.; Perkins, C.J.; Richterich, L.R. Westinghouse Hanford Co., Richland, WA (United States). Aug 1995. 300p. Sponsored by USDOE, Washington, DC (United States). DOE Contract AC06-87RL10930. Order Number DE96001069. Source: OSTI; NTIS; INIS; GPO Dep.

This document presents the results of the Westinghouse Hanford Company near-facility operational environmental monitoring for 1994 in the 100, 200/600, and 300/400 Areas of the Hanford Site, in south-central Washington State. Surveillance activities included sampling and analyses of ambient air surface water, groundwater, soil, sediments, and biota. Also, external radiation measurements and radiological surveys were taken at waste disposal sites, radiologically controlled areas, and roads. These activities were conducted to assess and control the effects of nuclear facilities and waste sites on the local environment. In addition, diffuse sources were monitored to determine compliance with Federal, State, and/or local regulations. In general, although effects from nuclear facilities are still seen on the Hanford Site and radiation levels are slightly elevated when compared to offsite locations, the differences are less than in previous years.

28992 (WHC-EP–0645) **Performance assessment for the disposal of low-level waste in the 200 West Area Burial Grounds.** Wood, M.I. (Westinghouse Hanford Co., Richland, WA (United States)); Khaleel, R.; Rittmann, P.D.; Lu, A.H.; Finfrock, S.H.; DeLorenzo, T.H.; Serne, R.J.; Cantrell, K.J. Westinghouse Hanford Co., Richland, WA (United States). Jun 1995. 483p. Sponsored by USDOE, Washington, DC (United States). DOE Contract AC06-87RL10930. Order Number DE95017141. Source: OSTI; NTIS; INIS; GPO Dep.

This document reports the findings of a performance assessment (PA) analysis for the disposal of solid low-level radioactive waste (LLW) in the 200 West Area Low-Level Waste Burial Grounds (LLBG) in the northwest corner of the 200 West Area of the Hanford Site. This PA analysis is required by US Department of Energy (DOE) Order 5820.2A (DOE 1988a) to demonstrate that a given disposal practice is in compliance with a set of performance objectives quantified in the order. These performance objectives are applicable to the disposal of DOE-generated LLW at any DOE-operated site after the finalization of the order in September 1988. At the Hanford Site, DOE, Richland Operations Office (RL) has issued a site-specific supplement to DOE Order 5820.2A, DOE-RL 5820.2A (DOE 1993), which provides additiona l ce objectives that must be satisfied.

28993 (WHC-EP–0871) **1995 solid waste 30-year container volume summary.** Templeton, K.J. (Pacific Northwest Lab., Richland, WA (United States)); DeForest, T.J.; Patridge, M.D. Westinghouse Hanford Co., Richland, WA (United States). Jul 1995. 126p. Sponsored by USDOE, Washington, DC (United States). DOE Contract AC06-87RL10930. Order Number DE95017153. Source: OSTI; NTIS; INIS; GPO Dep.

This report describes a 30-year forecast of the solid waste volumes by container category. The volumes described are low-level mixed waste (LLMW) and transuranic/transuranic mixed (TRU-TRUM) waste. These volumes and their associated container categories will be generated or received at the US Department of Energy Hanford Site for storage, treatment, and disposal at Westinghouse Hanford Company's Solid Waste Operations Complex (SWOC) during a 30-year period from FY 1995 through FY 2024. The data presented in this report establish a baseline for solid waste management both in the present and future. With knowledge of the volumes by container type, decisions on the facility handling and storage requirements can be adequately made. It is recognized that the forecast estimates will vary as facility planning and missions continue to change and become better defined; however, the data presented in this report still provide useful insight into Hanford's future solid waste management requirements.

28994 (WHC-SD-W236A-RPT–010) **A human factors engineering evaluation of the Multi-Function Waste Tank Facility. Final report.** Donohoo, D.T. (Pacific Northwest Lab., Richland, WA (United States)); Sarver, T.L. Westinghouse Hanford Co., Richland, WA (United States). 5 Jun 1995. 191p. Sponsored by USDOE, Washington, DC (United States). DOE Contract AC06-87RL10930. Order Number DE95015787. Source: OSTI; NTIS; INIS; GPO Dep.

This report documents the methods and results of a human factors engineering (HFE) review conducted on the Multi-Function Waste Tank Facility (MWTF), Westinghouse Hanford Company (WHC) Project 236A, to be constructed at the U.S. Department of Energy (DOE) facility at Hanford, Washington. This HFE analysis of the MWTF was initiated by WHC to assess how well the current facility and equipment design satisfies the needs of its operations

and maintenance staff and other potential occupants, and to identify areas of the design that could benefit from improving the human interfaces at the facility. Safe and effective operations, including maintenance, is a primary goal for the MWTF. Realization of this goal requires that the MWTF facility, equipment, and operations be designed in a manner that is consistent with the abilities and limitations of its operating personnel. As a consequence, HFE principles should be applied to the MWTF design, construction, its operating procedures, and its training. The HFE review was focused on the 200-West Area facility as the design is further along than that of the 200-East Area. The review captured, to the greatest extent feasible at this stage of design, all aspects of the facility activities and included the major topics generally associated with HFE (e.g., communication, working environment). Lessons learned from the review of the 200 West facility will be extrapolated to the 200-East Area, as well as generalized to the Hanford Site.

28995 (WHC-SD-WM-DR-013) **Description of waste pretreatment and interfacing systems dynamic simulation model.** Garbrick, D.J.; Zimmerman, B.D. Westinghouse Hanford Co., Richland, WA (United States). May 1995. 116p. Sponsored by USDOE, Washington, DC (United States). DOE Contract AC06-87RL10930. Order Number DE95016333. Source: OSTI; NTIS; INIS; GPO Dep.

The Waste Pretreatment and Interfacing Systems Dynamic Simulation Model was created to investigate the required pretreatment facility processing rates for both high level and low level waste so that the vitrification of tank waste can be completed according to the milestones defined in the Tri-Party Agreement (TPA). In order to achieve this objective, the processes upstream and downstream of the pretreatment facilities must also be included. The simulation model starts with retrieval of tank waste and ends with vitrification for both low level and high level wastes. This report describes the results of three simulation cases: one based on suggested average facility processing rates, one with facility rates determined so that approximately 6 new DSTs are required, and one with facility rates determined so that approximately no new DSTs are required. It appears, based on the simulation results, that reasonable facility processing rates can be selected so that no new DSTs are required by the TWRS program. However, this conclusion must be viewed with respect to the modeling assumptions, described in detail in the report. Also included in the report, in an appendix, are results of two sensitivity cases: one with glass plant water recycle steams recycled versus not recycled, and one employing the TPA SST retrieval schedule versus a more uniform SST retrieval schedule. Both recycling and retrieval schedule appear to have a significant impact on overall tank usage.

28996 (WHC-SD-WM-VI-020) **Test Plan: Phase 1, Hanford LLW melter tests, GTS Duratek, Inc.** Eaton, W.C. Westinghouse Hanford Co., Richland, WA (United States). 14 Jun 1995. 72p. Sponsored by USDOE, Washington, DC (United States). DOE Contract AC06-87RL10930. Order Number DE95016331. Source: OSTI; NTIS; INIS; GPO Dep.

This document provides a test plan for the conduct of vitrification testing by a vendor in support of the Hanford Tank Waste Remediation System (TWRS) Low-Level Waste (LLW) Vitrification Program. The vendor providing this test plan and conducting the work detailed within it [one of seven selected for glass melter testing under Purchase Order MMI-SVV-384215] is GTS Duratek, Inc., Columbia, Maryland. The GTS Duratek project manager for this work is J. Ruller. This test plan is for Phase I activities described in the above Purchase Order. Test conduct includes melting of glass with Hanford LLW Double-Shell Slurry Feed waste simulant in a DuraMelter™ vitrification system.

28997 (WSRC-MS-94-0640) **Microwave technology for waste management applications including disposition of electronic circuitry.** Wicks, G.G. (Westinghouse Savannah River Co., Aiken, SC (United States)); Clark, D.E.; Schulz, R.L.; Folz, D.C. Westinghouse Savannah River Co., Aiken, SC (United States). [1995]. 15p. Sponsored by USDOE, Washington, DC (United States). DOE Contract AC09-89SR18035. (CONF-9505249–11: 97. American Ceramic Society (ACS) annual meeting and exposition, Cincinnati, OH (United States), 2 May 1995). Order Number DE95017491. Source: OSTI; NTIS; INIS; GPO Dep.

Microwave technology is being developed nationally and internationally for a variety of environmental remediation purposes. These efforts include treatment and destruction of a vast array of gaseous, liquid and solid hazardous wastes as well as subsequent immobilization of selected components. Microwave technology provides an important contribution to an arsenal of existing remediation methods that are designed to protect the public and environment from undesirable consequences of hazardous materials. Applications of microwave energy for environmental remediation will be discussed. Emphasized will be a newly developed microwave process designed to treat discarded electronic circuitry and reclaim the precious metals within for reuse.

28998 (WSRC-MS–95-0184) **Defining the Glass Composition Limits for SRS Contaminated Soils.** Cicero, C.A. (Westinghouse Savannah River Company, Aiken, SC (United States)); Bickford, D.F.; Crews, W.O. Westinghouse Savannah River Co., Aiken, SC (United States). 12 May 1995. 20p. Sponsored by USDOE, Washington, DC (United States). DOE Contract AC09-89SR18035. (CONF-950877–18: 3. American Society for Mechanical Engineers biennial mixed waste symposium, Baltimore, MD (United States), 7-11 Aug 1995). Order Number DE96060001. Source: OSTI; NTIS; INIS; GPO Dep.

Contaminated soil resulting from the excavation, repair, and decommissioning of facilities located at the Savannah River Site (SRS) is currently being disposed of by shallow land burial or is being stored when considered only hazardous. Vitrification of this waste is being investigated, since it will bind the hazardous and radioactive species in a stable and durable glass matrix, which will reduce the risk of ground water contamination. However, the composition limits for producing durable glass have to be determined before the technology can be applied. Glass compositions, consisting of SRS soil and glass forming additives, were tested on a crucible-scale in three ternary phase systems. Nine different glass compositions were produced, with waste loadings ranging from 43 to 58 weight percent. These were characterized using varoius chemical methods and tested for durability in both alkaline and acidic environments. All nine performed well in alkaline environments, but only three met the strictest criteria for the acidic environment tests. Although the glasses did not meet all of the limits for the acidic tests, the test was performed on very conservative size samples, so the results were also conservative. Therefore, enough evidence was found to provide proof that SRS soil can be vitrified in a durable glass matrix.

28999 (WSRC-MS–95-0192) **Degradation of a N06690 borescope in a radioactive waste/glass melter system.** Imrich, K.J. Westinghouse Savannah River Co., Aiken, SC (United States). [1995]. 4p. Sponsored by USDOE, Washington, DC (United States). DOE Contract AC09-89SR18035. (CONF-950908–4: 2. international conference on heat resistant materials, Gatlinburg, TN (United States), 11-14 Sep 1995). Order Number DE95017479. Source: OSTI; NTIS; INIS; GPO Dep.

Radioactive liquid waste from nuclear materials production processes wi11 be vitrified in the Defense Waste Process Facility (DWPF) melter. The melter borescope outer housing, fabricated from N06690, was severely degraded by the combined effects of corrosion and oxidation after only five months of non radioactive operation. The melter was idled and not being fed over 85% of the time during the cold run operations. The borescope was designed to perform in an oxygen rich, chloride containing environment with temperatures approaching 900°C (1650°F). The housing was designed for a minimum of two years of continuous service in the DWPF melter. Air and steam were purged through the borescope and swept over the optics assembly to keep molten glass and volatile gases from depositing on the lens cover. Upon exiting the borescope the air passes through a N06690 orifice and enters the melter. Severe oxidation was observed around the orifice. Extensive material loss was also observed on the side of the outer housing which protrudes through the dome of the melter. Redesign of the borescope is currently underway and will include a new set of optics that will allow the size of the orifice to be significantly decreased, thus reducing the amount of air necessary to keep the lens cover clean. Application of a duplex diffusion coating, consisting of chromium and aluminum, on the end of the borescope outer

housing and the use of an inert gas purge are also being considered.

29000 (WSRC-MS–95-0353) **Extending Fuzzy System Concepts for Control of a Vitrification Melter.** Whitehouse, J.C. (Westinghouse Savannah River Company, AIKEN, SC (United States)); Sorgel, W.; Garrison, A.; Schalkoff, R.J. Westinghouse Savannah River Co., Aiken, SC (United States). 16 Aug 1995. 4p. Sponsored by USDOE, Washington, DC (United States). DOE Contract AC09-89SR18035. (CONF-9509229–1: 4. annual conference on fuzzy theory and technology, Wrightsville Beach, NC (United States), 28 Sep - 1 oct 1995). Order Number DE96060008. Source: OSTI; NTIS; GPO Dep.

Fuzzy systems provide a mathematical framework to capture uncertainty. The complete description of real, complex systems or situations often requires far more detail and information than could ever be obtained (or understood). Fuzzy approaches are an alternative technology for both system control and information processing and management. In this paper, we present the design of a fuzzy control system for a melter used in the vitrification of hazardous waste. Design issues, especially those related to melter shutdown and obtaining smooth control surfaces, are addressed. Several extensions to commonly-applied fuzzy techniques, notably adaptive defuzzification and modified rule structures are developed.

29001 (WSRC-TR–94-0618) **Bentonite mat demonstration. Final report.** Serrato, M.G. Westinghouse Savannah River Co., Aiken, SC (United States). 30 Dec 1994. 81p. Sponsored by USDOE, Washington, DC (United States). DOE Contract AC09-89SR18035. Order Number DE95017481. Source: OSTI; NTIS; GPO Dep.

The Bentonite Mat Demonstration was developed to provide the Environmental Restoration Department with field performance characteristics and engineering data for an alternative closure cover system configuration. The demonstration was initiated in response to regulatory concerns regarding the use of an alternative cover system for future design configurations. These design considerations are in lieu of the US Environmental Protection Agency (EPA) Recommended Design for Closure Cover Systems and specifically a single compacted kaolin clay layer with a hydraulic conductivity of 1×10^{-7} cm/sec. This alternative configuration is a composite geosynthetic material hydraulic barrier consisting from bottom to top: 2 ft compacted sandy clay layer (typical local Savannah River Site soil type) that is covered by a bentonite mat–geosynthetic clay liner (GCL) and is overlaid by a 40 mil High Density Polyethylene (HDPE) geomembrane–flexible membrane liner. This effort was undertaken to obtain and document the necessary field performance/engineering data for future designs and meet regulatory technical requirements for an alternative cover system configuration. The composite geosynthetic materials hydraulic barrier is the recommended alternative cover system configuration for containment of hazardous and low level radiological waste layers that have a high potential of subsidence to be used at the Savannah River Site (SRS). This alternative configuration mitigates subsidence effects in providing a flexible, lightweight cover system to maintain the integrity of the closure. The composite geosynthetic materials hydraulic barrier is recommended for the Sanitary Landfill and Low Level Radiological Waste Disposal Facility (LLRWDF) Closures.

29002 (WSRC-TR–95-0059) **Vitrification of actinide solutions in SRS separations facilities.** Minichan, R.L.; Ramsey, W.G. Westinghouse Savannah River Co., Aiken, SC (United States). [1995]. 9p. Sponsored by USDOE, Washington, DC (United States). DOE Contract AC09-89SR18035. (CONF-950216–156: Waste management '95, Tucson, AZ (United States), 26 Feb - 2 mar 1995). Order Number DE95017505. Source: OSTI; NTIS; INIS; GPO Dep.

The actinide vitrification system being developed at SRS provides the capability to convert specialized or unique forms of nuclear material into a stable solid glass product that can be safely shipped, stored or reprocessed according to the DOE complex mission. This project is an application of technology developed through funds from the Office of Technology Development (OTD). This technology is ideally suited for vitrifying relatively small quantities of fissile or special nuclear material since it is designed to be critically safe. Successful demonstration of this system to safely vitrify radioactive material could open up numerous opportunities for transferring this technology to applications throughout the DOE complex.

29003 (WSRC-TR–95-0071) **Replacement inhibitors for tank farm cooling coil systems.** Hsu, T.C. Westinghouse Savannah River Co., Aiken, SC (United States). 23 Mar 1995. 11p. Sponsored by USDOE, Washington, DC (United States). DOE Contract AC09-89SR18035. Order Number DE95017485. Source: OSTI; NTIS; INIS; GPO Dep.

Sodium chromate has been an effective corrosion inhibitor for the cooling coil systems in Savannah River Site (SRS) waste tanks for over 40 years. Due to their age and operating history, cooling coils occasionally fail allowing chromate water to leak into the environment. When the leaks spill 10 lbs. or more of sodium chromate over a 24-hr period, the leak incidents are classified as Unusual Occurrences (UO) per CERCLA (Comprehensive Environmental Response, Compensation and Liability Act). The cost of reporting and cleaning up chromate spills prompted High Level Waste Engineering (HLWE) to initiate a study to investigate alternative tank cooling water inhibitor systems and the associated cost of replacement. Several inhibitor systems were investigated as potential alternatives to sodium chromate. All would have a lesser regulatory impact, if a spill occurred. However, the conversion cost is estimated to be $8.5 million over a period of 8 to 12 months to convert all 5 cooling systems. Although each of the alternative inhibitors examined is effective in preventing corrosion, there is no inhibitor identified that is as effective as chromate. Assuming 3 major leaks a year (the average over the past several years), the cost of maintaining the existing inhibitor was estimated at $0.5 million per year. Since there is no economic or regulatory incentive to replace the sodium chromate with an alternate inhibitor, HLWE recommends that sodium chromate continue to be used as the inhibitor for the waste tank cooling systems.

29004 (WSRC-TR–95-0085) **Approximate cylindrical blast theory: Application to pressure loading.** Hutchens, G.J.; Gong, C. Westinghouse Savannah River Co., Aiken, SC (United States). [1995]. 13p. Sponsored by USDOE, Washington, DC (United States). DOE Contract AC09-89SR18035. Order Number DE95017502. Source: OSTI; NTIS; INIS; GPO Dep.

SRTC is currently investigating the use of plasma systems for immobilization of mixed low-level waste and transuranic waste. Much of this waste contains organic materials which are unstable in high temperature environments. For plasma technology to be viable for immobilization of these wastes, the breakdown of the organic materials must not pose a safety problem. To support start-up and operational planning for waste vitrification activities at SRS, an analysis has been performed to estimate the pressure load on a vessel wall due to an explosion. If, during routine operation of a waste vitrifier, a container with reactive material is injected, an explosion may result. With this in mind it is important to determine the pressure load on the container wall that results. The analysis performed below is a scoping calculation and is considered an R&D level 2 calculation based on the WSRC manual E-7. The objective of this analysis is to use near-field cylindrical blast theory to estimate the pressure load on a container wall due to an internal explosion. The blast theory result will then be compared to a structural calculation performed using ABAQUS. The ABAQUS calculations are to determine the pressure at which the container wall will fracture. Then, that pressure will be compared to the pressure given by blast theory for several explosive loadings.

29005 (WSRC-TR–95-0230) **Design Evaluation Process for Existing Waste Removal Design Documents.** Smith, P.D. Westinghouse Savannah River Co., Aiken, SC (United States). 12 May 1995. 6p. Sponsored by USDOE, Washington, DC (United States). DOE Contract AC09-89SR18035. Order Number DE96060006. Source: OSTI; NTIS; GPO Dep.

This document provides guidelines for implementing Engineering's responsibility relating to evaluating the adequacy of existing project design outputs. At this time, there exists design documents that were prepared and approved for modifications to operating facilities, that may or may not have been constructed, but have never been turned over to the Operating Facility Management. The process described herein describes the methodology to perform an evaluation of these existing designs and document the findings.

The key elements in this process are (1) to evaluate the existing design for general adequacy of the design, (2) to evaluate the existing design due to changes subsequent to the issuance of the documents (i.e. lessons learned, codes or standards change, changes to input documents, ect.), and (3) to verify the existence of critical supporting documentation in the areas of personnel safety, facility safety or environmental compliance.

29006 (WSRC-TR–95-0502) **Gamma weld-logging in burial ground of the Savannah River Site.** Winn, W.G.; Hofstetter, K.J.; MacMurdo, K.W. Westinghouse Savannah River Co., Aiken, SC (United States). [1995]. 6p. Sponsored by USDOE, Washington, DC (United States). DOE Contract AC09-89SR18035. (CONF-951006–23: Winter meeting of the American Nuclear Society, San Francisco, CA (United States), 29 Oct - 1 nov 1995). Order Number DE95017476. Source: OSTI; NTIS; INIS; GPO Dep.

Gamma well-logging measurements were conducted in an inactive, radioactive waste burial ground of the Savannah River Site to appraise whether any evidence existed for downward movement of radioactivity toward the water table. Similar measurements on the same wells were conducted earlier, providing a baseline from which to measure any changes in their radioactive plumes. In particular, the recent measurements sought to detect significant changes in depth location and radiation magnitude of the plumes, as well as the existence of any new plumes. By comparing measurements on a number of these wells, which were distributed on a grid pattern, it was anticipated that the general status of this section of the burial ground could be established.

29007 (Y/SUB–95-EAQ10C/2/P1) **Calendar year 1994 groundwater quality report for the Upper East Fork Poplar Creek Hydrogeologic Regime, Y-12 Plant, Oak Ridge, Tennessee: 1994 groundwater quality data and calculated rate of contaminant migration.** Oak Ridge Y-12 Plant, TN (United States); HSW Environmental Consultants, Inc., Oak Ridge, TN (United States). Feb 1995. 450p. Sponsored by USDOE, Washington, DC (United States). DOE Contract AC05-84OS21400. (Y/TS–1287). Order Number DE96000323. Source: OSTI; NTIS; GPO Dep.

This annual groundwater quality report (GWQR) contains groundwater and surface water quality data obtained during the 1994 calendar year (CY) at several waste-management facilities and a petroleum fuel underground storage tank (UST) site associated with the US Department of Energy (DOE) Y-12 Plant located on the DOE Oak Ridge Reservation (ORR) southeast of Oak Ridge, Tennessee. The sites addressed by this document are located within the Upper East Fork Poplar Creek Hydrogeologic Regime (East Fork Regime). The East Fork Regime, which is one of three hydrogeologic regimes defined for the purposes of groundwater quality monitoring at the Y-12 Plant, encompasses the Y-12 Plant. The regime extends west from a surface water and shallow groundwater divide located near the west end of the plant to Scarboro Road (directions in this report are in reference to the Y-12 Plant grid system unless otherwise noted). The Environmental Management Department of the Y-12 Plant Health, Safety, Environment, and Accountability (HSEA) Organization manages the groundwater monitoring activities in each regime as part of the Y-12 Plant Groundwater Protection Program (GWPP). The purpose of the GWPP is to characterize the hydrogeology and to monitor groundwater quality at the Y-12 Plant and surrounding area to provide for protection of groundwater resources consistent with federal, state, and local requirements and in accordance with DOE Orders and Energy Systems corporate policy.

29008 (Y/SUB–95-EAQ10C/3/P1) **Calendar year 1994 groundwater quality report for the Chestnut Ridge Hydrogeologic Regime, Y-12 Plant, Oak Ridge, Tennessee. 1994 groundwater quality data and calculated rate of contaminant migration.** Oak Ridge Y-12 Plant, TN (United States); HSW Environmental Consultants, Inc., Oak Ridge, TN (United States). Feb 1995. 350p. Sponsored by USDOE, Washington, DC (United States). DOE Contract AC05-84OS21400. Order Number DE96000322. Source: OSTI; NTIS; GPO Dep.

This annual groundwater quality report (GWQR) contains groundwater quality data obtained during the 1994 calendar year (CY) at several hazardous and non-hazardous waste-management facilities associated with the US Department of Energy (DOE) Y-12 Plant located on the DOE Oak Ridge Reservation (ORR) southeast of Oak Ridge, Tennessee (Figure 1). These sites are located south of the Y-12 Plant in the Chestnut Ridge Hydrogeologic Regime (Chestnut Ridge Regime), which is one of three regimes defined for the purposes of groundwater quality monitoring at the Y- 12 Plant. The Environmental Management Department of the Y-12 Plant Health, Safety, Environment, and Accountability (HSEA) Organization manages the groundwater monitoring activities in each regime as part of the Y-12 Plant Groundwater Protection Program (GWPP). The GWQR for the Chestnut Ridge Regime is completed in two-parts: Part 1 (this report) containing the groundwater quality data and Part 2 containing a detailed evaluation of the data. The primary purpose of this report is to serve as a reference containing the groundwater quality data obtained each year under the lead of the Y-12 Plant GWPP. However, because it contains information needed to comply with Resource Conservation and Recovery Act (RCRA) interim status assessment monitoring and reporting requirements, this report is submitted to the Tennessee Department of Environment and Conservation (TDEC) by the RCRA reporting deadline (March 1 of the following CY). Part 2 of the annual groundwater report, to be issued mid-year, will contain a regime-wide evaluation of groundwater quality, present the findings and status of ongoing hydrogeologic studies, describe changes in monitoring priorities, and present planned modifications to the groundwater sampling and analysis activities.

29009 (Y/TS–843/R2) **Resource Conservation and Recovery Act (RCRA). Part B, Permit application for the production and classified Waste Storage Units at the Oak Ridge Y-12 Plant. Building 9720-32 Production Waste Storage Unit; Building 9720-59 Classified Waste Storage Unit.** Oak Ridge Y-12 Plant, TN (United States). 10 Jul 1995. 300p. Sponsored by USDOE, Washington, DC (United States). DOE Contract AC05-84OR21400. Order Number DE96000296. Source: OSTI; NTIS; INIS; GPO Dep.

This report is a permit application for radioactive and hazardous waste storage units at the Oak Ridge Y-12 plant. Topics discussed include: topography; location information; chemical and physical analysis of wastes; waste analysis plan; container systems; measures to prevent hazards; security; inspection schedule; contingency plan; emergence response procedures; emergency equipment; personnel training; closure plan, post closure plan; and financial requirements; federal laws; organic air emissions sampling plan; solid waste management units; and certification.

0530 Environmental Aspects

Refer also to citation(s) 28794, 28796, 28797, 28807, 28809, 28815, 28823, 28826, 28892, 28894, 28895, 28896, 28898, 28899, 28903, 28905, 28988, 29045, 29049, 29051, 29052, 29056, 29058, 29064, 29081, 29082, 29085, 29105, 29117, 30627, 30628, 30629, 30630, 30763, 30824

29010 (CONF-940553–86) **Observations of water movement in a block of fractured welded Tuff.** Thamir, F. (Geological Survey, Denver, CO (United States)); Kwicklis, E.M.; Hampson, D.; Anderton, S. Geological Survey, Denver, CO (United States). [1994]. 10p. Sponsored by USDOE, Washington, DC (United States). DOE Contract AI08-92NV10874. From International high-level radioactive waste management conference; Las Vegas, NV (United States); 22-26 May 1994. Order Number DE96001452. Source: OSTI; NTIS; INIS; GPO Dep.

A laboratory water infiltration experiment through a block of fractured, moderately welded volcanic tuff was conducted at different boundary pressures. The block measured 47.5 cm long x 54.3 cm wide x 80.6 cm high. The purpose of the experiment was: (a) to test an instrumentation scheme for a field test, and (b) to make flow measurements through a fractured network at different boundary pressures to understand mechanisms that affect fracture flow. The upper boundary water pressure was decreased in steps; each step lasted several weeks where the pressure was kept steady. Water inflow and outflow rates were measured for each boundary condition. Entrapped air was found to impede water movement. The gas phase in the fracture network was found to not be continuous; its pressure within the network was not known. The matric

potential values could not be measured with tensiometers alone since a known gas pressure is required. Long-term input and output flow rates were equal. Outflow rate did not stabilize during the test period; it continued to decrease, even when the upper boundary water pressure was kept steady. No relation between boundary pressure and flow rate was established. Bacteria, which was found in the outflow, possibly caused variations in the behavior. Trapped air caused the outflow to periodically decrease or stop; however, outflow rates following the interruptions did not change long-term flow trends.

29011 (CONF-940553–90) **Hydrologic property alterations due to elevated temperatures at Yucca Mountain.** Flint, A.L. (Geological Survey, Mercury, NV (United States)); Nash, M.H.; Nash, M.S. Geological Survey, Denver, CO (United States). [1994]. 6p. Sponsored by USDOE, Washington, DC (United States). DOE Contract AI08-92NV10874. From International high-level radioactive waste management conference; Las Vegas, NV (United States); 22-26 May 1994. Order Number DE96001456. Source: OSTI; NTIS; INIS; GPO Dep.

Yucca Mountain is currently being evaluated as a potential site for a high level nuclear waste repository. The pre-emplacement hydrologic properties of the rock are important in determining the suitability of the site; however, post emplacement thermal loads and associated drying may permanently alter the character of the rock. A preliminary study was undertaken to determine the effects of elevated temperatures on hydrologic properties of the welded Topopah Spring member of the Paintbrush Tuff and a zeolitic, nonwelded tuff from the Tuffaceous Beds of Calico Hills. Rock outcrop samples were collected and dried in the laboratory at different temperatures (up to 400 degrees C). Hydrologic and physical properties -were tested before and after each of the drying cycles.

29012 (CONF-940553–93) **Simulation of flow in the unsaturated zone beneath Pagany Wash, Yucca Mountain.** Thamir, F. (Geological Survey, Denver, CO (United States)); Kwicklis, E.M.; Hampson, D.; Anderton, S. Geological Survey. Denver, CO (United States). [1994]. 10p. Sponsored by USDOE, Washington, DC (United States). DOE Contract AI08-92NV10874. From International high-level radioactive waste management conference; Las Vegas, NV (United States); 22-26 May 1994. Order Number DE96001459. Source: OSTI; NTIS; INIS; GPO Dep.

A one-dimensional numerical model was created simulate water movement beneath Pagany Wash, Yucca Mountain, Nevada. Model stratigraphy and properties were on data obtained from boreholes UE-25 UZ #4 UE-25 UZ #5, which were drilled in the alluvial channel and bedrock sideslope of Pagany Wash. Although unable to account for multidimensional or preferential flowpaths beneath the wash, the model proved a useful conceptual tool with which to develop hypotheses and, in some cases, provide bounding calculations. The model indicated that liquid flux decreases with depth in the upper 120 m beneath the wash, with fluxes of several tens mm/yr in the nonwelded base of the Tiva Canyon Member and fluxes on the order of a tenth mm/yr in the upper Topopah Spring Member. Capillary barrier effects were indicated by the model to significantly delay the entry of large fluxes into the potential repository horizon during periods of increasing net infiltration, and to inhibit rapid drainage of water from the nonwelded and bedded intervals into the potential repository horizon during periods of moisture redistribution. Lateral moisture redistribution can be expected to be promoted by these effects.

29013 (DOE/RL–94-30) **Riverland expedited response action assessment.** USDOE Richland Operations Office, WA (United States); Bechtel National, Inc., Richland, WA (United States). Jun 1995. 30p. Sponsored by USDOE, Washington, DC (United States). DOE Contract AC06-93RL12367. Order Number DE95017534. Source: OSTI; NTIS; INIS; GPO Dep.

The US Environmental Protection Agency (EPA) and Washington Department of Ecology (Ecology) recommended that the US Department of Energy (DOE) prepare an expedited response action (ERA) for the Riverland Railroad Car Wash Pit (located in the Riverland Rail Yard) and the 600 Area Army Munitions Burial Site (Munitions Cache). This assessment report details the actions taken to complete the Riverland ERA.

29014 (DOE/RL–94-61-Vol.2) **100 Area Source Operable Unit focused feasibility study. Volume 2.** USDOE Richland Operations Office, WA (United States); Bechtel National, Inc., Richland, WA (United States). Aug 1995. 60p. Sponsored by USDOE, Washington, DC (United States). DOE Contract AC06-93RL12367. Order Number DE95017537. Source: OSTI; NTIS; INIS; GPO Dep.

This 100-KR-1 Operable Unit Focused Feasibility Study (FFS) is prepared in support of the Comprehensive Environmental Response, Compensation, and Liability Act of 1980 (CERCLA) remedial investigation/feasibility study (RI/FS) process for the 100 Areas. This 100-KR-1 FFS, evaluates the remedial alternatives for interim action at high-priority waste sites within the 100-KR-1 Operable Unit, and provides the information needed for the timely selection of the most appropriate interim action at each waste site. The FFS process for the 100 Areas is conducted in two stages: an evaluation of remedial alternatives for waste-site groups and an evaluation of the remedial alternatives for individual waste sites. Whenever the characteristics of the individual waste-sites are sufficiently similar to the characteristics of the waste-site groups, the evaluation of alternatives in the Process Document is used. This approach, referred to as the "plug-in" approach, is used because there are many waste sites within the 100 Areas that are similar to each other.

29015 (DOE/RL–94-99) **Proposed plan for interim remedial measures at the 100-BC-1 Operable Units.** USDOE Richland Operations Office, WA (United States); Bechtel National, Inc., Richland, WA (United States). Jun 1995. 16p. Sponsored by USDOE, Washington, DC (United States). DOE Contract AC06-93RL12367. Order Number DE95017538. Source: OSTI; NTIS; INIS; GPO Dep.

This Proposed Plan identifies the preferred alternative for interim remedial measures for remedial action of radioactive liquid waste disposal sites that include contaminated soils and structures at the 100-BC-1 Operable Unit, located at the Hanford Site. It also summarizes other remedial alternatives evaluated for interim remedial measures in this Operable Unit. The intent of interim remedial measures is to speed up actions to address contaminated areas that pose potential threats to human health and the environment. The preferred alternative presented in this Proposed Plan is to remove, treat as appropriate or required, and dispose of the contaminated soil and associated structures from nine source areas within the 100-BC-1 Operable Unit. Treatment would be conducted as necessary or appropriate for cost effective operations. The preferred alternative will reduce potential threats to human health and the environment at 100-BC-1 Operable Unit radioactive liquid waste disposal sites. The remedial actions described are intended to reduce potential human health and ecological risks and to ensure that contaminants present at these waste sites will not adversely impact groundwater beneath the sites or the Columbia River.

29016 (DOE/RL–94-100) **Proposed plan for interim remedial measures at the 100-DR-1 Operable Unit.** USDOE Richland Operations Office, WA (United States); Bechtel National, Inc., Richland, WA (United States). Jun 1995. 16p. Sponsored by USDOE, Washington, DC (United States). DOE Contract AC06-93RL12367. Order Number DE95017540. Source: OSTI; NTIS; INIS; GPO Dep.

This proposed plan identifies the preferred alternative for interim remedial measures for remedial action of radioactive liquid waste disposal sites that include contaminated soils and structures at the 100-DR-1 Operable Unit, located at the Hanford Site. It also summarizes other remedial alternatives evaluated for interim remedial measures in this Operable Unit. The intent of interim remedial measures is to speed up actions to address contaminated areas that pose potential threats to human health and the environment. The preferred alternative presented in this Proposed Plan is to remove, treat as appropriate or required, and dispose of the contaminated soil and associated structures from twelve source areas within the 100-DR-1 Operable Unit. The preferred alternative will reduce potential threats to human health and the environment at 100-DR-1 Operable Unit radioactive liquid waste disposal sites. The remedial actions described are intended to reduce potential human health and ecological risks and to ensure that contaminants present at these waste sites will not adversely impact groundwater beneath the sites or the Columbia River.

29017 (DOE/RL–94-101-Rev.1) **Proposed plan for interim remedial measures at the 100-HR-1 Operable Unit. Revision 1.** USDOE Richland Operations Office, WA (United States); Bechtel National, Inc., Richland, WA (United States). Jun 1995. 15p. Sponsored by USDOE, Washington, DC (United States). DOE Contract AC06-93RL12367. Order Number DE95017541. Source: OSTI; NTIS; INIS; GPO Dep.

This Proposed Plan identifies the preferred alternative for interim remedial measures for remedial action of radioactive liquid waste disposal sites that include contaminated soils and structures at the 100-HR-1 Operable Unit, located at the Hanford Site. It also summarizes other remedial alternatives evaluated for interim remedial measures in this Operable Unit. The intent of interim remedial measures is to speed up actions to address contaminated areas that pose potential threats to human health and the environment. The preferred alternative presented in this Proposed Plan is to remove, treat (as appropriate or required), and dispose of the contaminated soil and associated structures from three source areas within the 100-HR-1 Operable Unit. These are the 116-H-1 Process Effluent Trench, the 116-H-7 Retention Basin, and the 100-H Buried Process Effluent Pipelines. The preferred alternative will reduce potential threats to human health and the environment at 100-HR-1 Operable Unit radioactive liquid waste disposal sites. The remedial actions described are intended to reduce potential human health and ecological risks and to ensure that contaminants present at these waste sites will not adversely impact groundwater beneath the sites or the Columbia River.

29018 (DOE/RL–94-102) **Proposed plan for interim remedial measure at the 100-HR-3 Operable Unit.** USDOE Richland Operations Office, WA (United States); Bechtel National, Inc., Richland, WA (United States). Aug 1995. 15p. Sponsored by USDOE, Washington, DC (United States). DOE Contract AC06-93RL12367. Order Number DE95017545. Source: OSTI; NTIS; INIS; GPO Dep.

This Proposed Plan identifies the preferred alternative for an interim remedial measure at the 100-HR-3 Operable Unit, located at the Hanford Site. It also summarizes other alternatives evaluated for interim remedial measures in this operable unit. The intent of an interim remedial measure is to speed up actions to address contaminated areas that pose threats to human health or the environment. This Proposed Plan is intended to be a fact sheet for public review that briefly describes the remedial alternatives that have been analyzed, identifies the preferred alternative, and summarizes the information relied upon to recommend the preferred alternative. The preferred alternative presented in this Proposed Plan is to remove contaminated groundwater from the 100-HR-3 Operable Unit, treat it by ion exchange, and dispose of treated groundwater by using upgradient injection wells to return it to the aquifer.

29019 (DOE/RL–94-102-Rev.1) **Proposed plan for interim remedial measure at the 100-HR-3 Operable Unit. Revision 1.** USDOE Richland Operations Office, WA (United States); Bechtel National, Inc., Richland, WA (United States). Sep 1995. 15p. Sponsored by USDOE, Washington, DC (United States). DOE Contract AC06-93RL12367. Order Number DE95017501. Source: OSTI; NTIS; INIS; GPO Dep.

Operable Unit, located at the Hanford Site. It also summarizes other alternative evaluated for interim remedial measures in this operable unit. The intent of an interim remedi measure is to speed up actions to address contaminate areas that pose threats to human health or environment. This Proposed Plan is intended to be a fact sheet for public review that briefly describes the remedial alternatives that have been analyzed, identifies the preferred alternative, and summarizes the information relied upon to recommend the preferred alternative. The preferred alternative presented in this Proposed Plan is to remove contaminated groundwater from the 100-HR-3 Operable Unit, treat it by ion exchange, and dispose of treated groundwater by using upgradient injection wells to return it to the aquifer.

29020 (DOE/RL–94-113-Rev.1) **Proposed plan for interim remedial measure at the 100-KR-4 operable unit, Revision 1.** USDOE Richland Operations Office, WA (United States). Sep 1995. 15p. Sponsored by USDOE, Washington, DC (United States). DOE Contract AC06-93RL12367. Order Number DE95017496. Source: OSTI; NTIS; INIS; GPO Dep.

This proposed plan identifies the preferred alternative for an interim remedial action plan for the 100-KR-4 Operable Unit at the Hanford Site. The alternative presented is to remove contaminated groundwater from the Unit, treat it by ion exchange, and then dispose of treated groundwater by using upgradient injection wells to return it to the acquifer. This will protect the Columbia River environment from toxic hexavalent chromium. This alternative is the initial recommendation of the EPA, Ecology, and the DOE. Public comment on this plan is invited.

29021 (DOE/RL–94-119) **Proposal plan for interim remedial measures at the 100-KR-1 operable unit, Revision 0.** USDOE Richland Operations Office, WA (United States). Aug 1995. 15p. Sponsored by USDOE, Washington, DC (United States). DOE Contract AC06-93RL12367. Order Number DE95017512. Source: OSTI; NTIS; INIS; GPO Dep.

This proposed plan identifies the preferred alternative for interim remedial measures for remedial action at the 100-KR-1 Operable Unit at the Hanford Site. The alternative presented in this plan is to remove, treat, and dispose of the contaminated soil and associated structures from five waste sites within the Unit. These actions will reduce potential human health and ecological risks, ensure that contaminants present will not adversely affect groundwater, and leave the site suitable for future use. This alternative is the initial recommendation of the EPA, Ecology, and the DOE. Public comment on this plan is solicited.

29022 (DOE/RL–95-26) **Interim remedial measure proposed plan for the 200-UP-1 operable unit, Hanford, Washington, Revision 0.** USDOE Richland Operations Office, WA (United States). Aug 1995. 13p. Sponsored by USDOE, Washington, DC (United States). DOE Contract AC06-93RL12367. Order Number DE95017529. Source: OSTI; NTIS; INIS; GPO Dep.

This interim remedial measure (IRM) proposed plan describes an interim action that is proposed for the 200-UP-1 Groundwater Operable Unit (200-UP-1) located in the 200 West Area of the U.S. Department of Energy's (DOE) Hanford Site. The Hanford Site is a 560-square mile federal facility located near the city of Richland in Benton County, Washington. The 200-UP-1 addresses certain groundwater contaminants in southern portions of the 200 West Area. The objectives of this IRM are to contain elevated concentrations of uranium and technetium-99 in 200-UP-1 and collect data on aquifer and contaminant response to the remediation measure. Monitoring data indicate that the highest concentrations of these contaminants are within the boundary of the 200 West Area. However, lower concentrations of these contaminants have migrated beyond the 200 West Area boundary.

29023 (DOE/RL–95-30) **200-ZP-1 Operable Unit Treatability Test Report.** USDOE Richland Operations Office, WA (United States); Bechtel National, Inc., Richland, WA (United States). Jul 1995. 50p. Sponsored by USDOE, Washington, DC (United States). DOE Contract AC06-93RL12367. Order Number DE95017544. Source: OSTI; NTIS; INIS; GPO Dep.

A pilot-scale treatability test was performed in the 200-ZP-1 groundwater operable unit, located in the 200 West Area of the Hanford Site. The performance of the test was based on the Treatability Test Plan for the 200-ZP-1 Operable Unit (DOE-RL 1994b) and an agreement between the US Department of Energy (DOE), the US Environmental Protection Agency (EPA), and the Washington State Department of Ecology (Ecology) documented in the Hanford Federal Facility Agreement and Consent Order (Tri-Party Agreement) (Change Control Form M-13-93-03). The pilot-scale treatability test was conducted on the volatile organic compound (VOC) contaminant plume associated with the 200-ZP-1 Operable Unit and focused on assessing the performance of an aboveground treatment system with respect to its ability to remove carbon tetrachloride, chloroform, and trichloroethylene from extracted groundwater.

29024 (DOE/RL–95-60) **Proposed plan for the 100-IU-1, 100-IU-3, 100-IU-4, AND 100-IU-5 Operable Units.** USDOE Richland Operations Office, WA (United States); Bechtel National, Inc., Richland, WA (United States). Jun 1995. 9p. Sponsored by USDOE,

Washington, DC (United States). DOE Contract AC06-93RL12367. Order Number DE95017497. Source: OSTI; NTIS; INIS; GPO Dep.

This proposed plan identifies the preferred alternative for the Riverland Rad Yard, the Wahluke Slope, the Sodium Dichromate Baffel Landfill, and the, White Bluffs Pickling Acid Cribs, located at the Hanford Site. These areas are known respectively as the 100-IU-1, 100-IU-3, 100-IU-4, and 100-IU-5 Operable Units. Between 1992 and 1994, each of the four operable units was the subject of an expedited response action that addressed removal of site contaminants in soil. Waste sites in the 100-IU-2 (White Bluffs Townsite) and 100-IU-6 (Hanford Townsite) Operable Units will be addressed in future proposed plans. A proposed plan is intended to be a fact sheet for public review that summarizes the information relied upon to recommend the preferred alternative. As presented in this proposed plan, no further action is the preferred alternative for the final resolution of the 100-IU-1, 100-IU-3, 100-IU-4, and 100-IU-5 Operable Units. The preferred alternative is recommended because all suspect hazardous substances above cleanup levels have been removed from the waste sites, and the sites are unlikely to pose any significant risk to human health or the environment.

29025 (FEMP/SUB--102) **Natural phenomena hazards evaluation of concrete silos 1, 2, 3 and 4 at Fernald, Ohio.** Char, C.V. (PARSONS Environmental Remedial Action Project, Fairfield, OH (United States)); Shiner, T.J. Fernald Environmental Restoration Management Corp., Cincinnati, OH (United States). Fernald Environmental Management Project. Aug 1995. 15p. Sponsored by USDOE, Washington, DC (United States). DOE Contract AC24-92OR21972. (CONF-9511128--1: DOE natural phenomena hazards mitigation symposium, Denver, CO (United States), 13-14 Nov 1995). Order Number DE96000320. Source: OSTI; NTIS; INIS; GPO Dep.

Fernald Environmental Management Project (FEMP) is a United States Department of Energy (DOE) site located near Cincinnati, Ohio. FEMP was formerly established as the Feed Materials Production Center (FMPC) in 1951 under the Atomic Energy Commission. FEMP is currently undergoing site wide environmental remediation. This paper addresses four concrete silos built during the 1950s and located in Operable Unit 4 (OU-4). Silos 1 and 2 known as K-65 Silos contain residues from Uranium Ore processing. Silo 3 contains metal oxides in powder form. Silo 4 is empty. The Silos are categorized as low hazard facilities and the Natural Phenomena Hazards (NPH) performance category is PC-2, based on a recently completed safety analysis report. This paper describes the structural evaluation of concrete Silos 1, 2, 3 and 4 for NPH. Non Destructive Tests (NDT) were conducted to establish the current conditions of the silos. Analytical and computer methods were used to evaluate the stresses and displacements for different silo configurations and different loading combinations. Finite element models were developed to uniquely represent each silo, and analyzed using SAP90 computer program. The SAPLOT post processor was used for rapid determination of critical areas of concern for critical loading combinations and for varying silo configurations.

29026 (IS--5115) **Final report, Ames Mobile Laboratory Project: The development and operation of instrumentation in a mobile laboratory for in situ, real-time screening and characterization of soils using the laser ablation sampling technique.** Anderson, M.S.; Braymen, S.D. Ames Lab., IA (United States). 27 Jan 1995. 30p. Sponsored by USDOE, Washington, DC (United States). DOE Contract W-7405-ENG-82. Order Number DE96000889. Source: OSTI; NTIS; INIS; GPO Dep.

The main focus of the Ames Laboratory's Technology Integration Program, TIP, from May 1991 through December 1994 was the development, fabrication, and demonstration of a mobile instrumentation laboratory incorporating rapid in situ sampling systems for safe, rapid, and cost effective soil screening/characterization. The Mobile Demonstration Laboratory for Environmental Screening Technologies, MDLEST, containing the analysis instrumentation, along with surface and subsurface sampling probe prototypes employing the laser ablation sampling technique were chosen to satisfy the particular surface and subsurface soil characterization needs of the various Department of Energy facilities for determining the extent of heavy metal and radionuclide contamination. The MDLEST, a 44 foot long 5th wheel trailer, is easily configured for the analysis instrumentation and sampling system required for the particular site work. This mobile laboratory contains all of the utilities needed to satisfy the operating requirements of the various instrumentation installed. These utilities include, an electric generator, a chilled water system, process gases, a heating/air conditioning system, and computer monitoring and automatic operating systems. Once the MDLEST arrives at the job site, the instrumentation is aligned and calibration is completed, sampling and analysis operations begin. The sample is acquired, analyzed and the results reported in as little as 10 minutes. The surface sampling probe is used in two modes to acquire samples for analysis. It is either set directly on the ground over the site to be sampled, in situ sampling, or in a special fixture used for calibrating the sampling analysis system with standard soil samples, having the samples brought to the MDLEST. The surface sampling probe was used to in situ sample a flat concrete surface (nondestructively) with the ablated sample being analyzed by the instrumentation in the MDLEST.

29027 (LA--13015-MS) **Radionuclide contaminant analysis of small mammals at Area G, TA-54, 1994.** Biggs, J.; Bennett, K.; Fresquez, P. Los Alamos National Lab., NM (United States). Sep 1995. 34p. Sponsored by USDOE, Washington, DC (United States). DOE Contract W-7405-ENG-36. Order Number DE96000058. Source: OSTI; NTIS; INIS; GPO Dep.

Small mammals were sampled at two waste burial sites (1 and 2) at Area G, TA-54 and a control site outside Area G (Site 3) to identify radionuclides that are present within surface and subsurface soils at waste burial sites, to compare the amount of radionuclide uptake by small mammals at waste burial sites to a control site, and to identify the primary mode of contamination to small mammals, either through surface contact or ingestion/inhalation. Three composite samples of at least five animals per sample were collected at each site. Pelts and carcasses of each animal were separated and analyzed independently. Samples were analyzed for ^{241}Am, ^{90}Sr, ^{238}Pu, ^{239}Pu, total U, and gamma spectroscopy (including ^{137}Cs). Significantly higher (parametric t-test at $p = 0.05$) levels of total U, ^{241}Am, ^{238}Pu, ^{239}Pu, and ^{40}K were detected in pelts as compared to the carcasses of small mammals at TA-54. Concentrations of other measured radionuclides in carcasses were nearly equal to or exceeded the mean concentrations in the pelts. The authors results show higher concentrations in pelts compared to carcasses which is similar to what has been found at waste burial/contaminated sites outside of Los Alamos National Laboratory. Site 1 had significantly higher (alpha = 0.05, F = 0.0095) total U concentrations in carcasses than Sites 2 and 3. Site 2 had significantly higher (alpha = 0.05, F = 0.0195) ^{239}Pu concentrations in carcasses than either Site 1 or Site 3. A significant difference in ^{90}Sr concentration existed between Sites 1 and 2 (alpha = 0.05, F = 0.0681) and concentrations of ^{40}K at Site 1 were significantly different from Site 3.

29028 (LA--13028-MS) **Baseline radionuclide concentrations in soils and vegetation around the proposed Weapons Engineering Tritium Facility and the Weapons Subsystems Laboratory at TA-16.** Fresquez, P.R.; Ennis, M. Los Alamos National Lab., NM (United States). Sep 1995. 15p. Sponsored by USDOE, Washington, DC (United States). DOE Contract W-7405-ENG-36. Order Number DE96000053. Source: OSTI; NTIS; INIS; GPO Dep.

A preoperational environmental survey is required by the Department of Energy (DOE) for all federally funded research facilities that have the potential to cause adverse impacts on the environment. Therefore, in accordance with DOE Order 5400.1, an environmental survey was conducted over the proposed sites of the Weapons Engineering Tritium Facility (WETF) and the Weapons Subsystems Laboratory (WSL) at Los Alamos National Laboratory (LANL) at TA-16. Baseline concentrations of tritium (^{3}H), plutonium (^{238}Pu and ^{239}Pu) and total uranium were measured in soils, vegetation (pine needles and oak leaves) and ground litter. Tritium was also measured from air samples, while cesium (^{137}Cs) was measured in soils. The mean concentration of airborne tritiated water during 1987 was 3.9 pCi/m^3. Although the mean annual concentration of ^{3}H in soil moisture at the 0–5 cm (2 in) soil depth was measured at 0.6 pCi/mL, a better background

level, based on long-term regional data, was considered to be 2.6 pCi/mL. Mean values for ^{137}Cs, ^{218}Pu, ^{239}Pu, and total uranium in soils collected from the 0–5 cm depth were 1.08 pCi/g, 0.0014 pCi/g, 0.0325 pCi/g, and 4.01 μg/g, respectively. Ponderosa pine (Pinus ponderosa) needles contained higher values of ^{238}Pu, ^{239}Pu, and total uranium than did leaves collected from gambel's oak (Quercus gambelii). In contrast, leaves collected from gambel's oak contained higher levels of ^{137}Cs than what pine needles did.

29029 (LBL–37200, pp. 14-20) **The use of TOUGH2 for the LBL/USGS 3-dimensional site-scale model of Yucca Mountain, Nevada.** Bodvarsson, G. (Lawrence Berkeley Laboratory, CA (United States)); Chen, G.; Haukwa, C. Lawrence Berkeley Lab., CA (United States). Mar 1995. DOE Contract AC03-76SF00098. (CONF-9503110–: TOUGH 95: transport of unsaturated ground water and heat workshop, Berkeley, CA (United States), 20-22 Mar 1995). In *Proceedings of the TOUGH Workshop '95 Lawrence Berkeley Laboratory, Berkeley, California, March 20–22, 1995.* 380p. Order Number DE95014788. Source: OSTI; NTIS; GPO Dep.

The three-dimensional site-scale numerical model of the unsaturated zone at Yucca Mountain is under continuous development and calibration through a collaborative effort between Lawrence Berkeley Laboratory (LBL) and the United States Geological Survey (USGS). The site-scale model covers an area of about 30 km^2 and is bounded by major fault zones to the west (Solitario Canyon Fault), east (Bow Ridge Fault) and perhaps to the north by an unconfirmed fault (Yucca Wash Fault). The model consists of about 5,000 grid blocks (elements) with nearly 20,000 connections between them the grid was designed to represent the most prevalent geological and hydro-geological features of the site including major faults, and layering and bedding of the hydro-geological units. Further information about the three-dimensional site-scale model is given by Wittwer et al. and Bodvarsson et al.

29030 (LBL–37200, pp. 58-68) **Parametric analysis of a TOUGH2 model for the unsaturated zone at Yucca Mountain.** Xiang, Y. (CRWMS M&O/INTERA, Inc., Las Vegas, NV (United States)); Mishra, S.; Dunlap, B. Lawrence Berkeley Lab., CA (United States). Mar 1995. DOE Contract AC03-76SF00098. (CONF-9503110–: TOUGH 95: transport of unsaturated ground water and heat workshop, Berkeley, CA (United States), 20-22 Mar 1995). In *Proceedings of the TOUGH Workshop '95 Lawrence Berkeley Laboratory, Berkeley, California, March 20–22, 1995.* 380p. Order Number DE95014788. Source: OSTI; NTIS; GPO Dep.

Yucca Mountain in Nevada is currently being investigated for suitability as a potential site for the disposal of high-level radioactive waste and spent nuclear fuel. As the most important natural barrier against radionuclide migration to the accessible environment, the unsaturated zone at Yucca mountain is a key constituent in assessing the ambient geohydrology. A three-dimensional site-scale TOUGH2 model of the unsaturated zone is currently under development by Lawrence Berkeley Laboratory (LBL) and the United States Geological Survey (USGS) consists of six hydrogeologic units - TCw (Tiva Canyon welded), PTn (Paintbrush nonwelded), TSw (Topopah Spring welded), TSv (Topopah Spring welded-vitrophyre), CHnz (Calico Hills nonwelded-vitric), and CHnz (Calico Hills nonwelded-zeolitic), which are further subdivided into seventeen layers to represent additional lithologic detail. Based on the work of Klavetter and Peters, the fractured units TCw and TSw are treated as equivalent continua with specified threshold saturation for triggering fracture flow.

29031 (ORNL/TM–13039) **Surface radiological investigations at the proposed SWSA 7 Site, Oak Ridge National Laboratory, Oak Ridge, Tennessee.** McKenzie, S.P.; Murray, M.E.; Uziel, M.S. Oak Ridge National Lab., TN (United States). Aug 1995. 65p. Sponsored by USDOE, Washington, DC (United States). DOE Contract AC05-84OR21400. Order Number DE95017311. Source: OSTI; NTIS; GPO Dep.

A surface radiological investigation was conducted intermittently from June 1994 to June 1995 at the proposed site for Solid Waste Storage Area (SWSA) 7. The stimulus for this survey was the observation in June 1992 of a man's trousers became contaminated with ^{90}Sr while he was reviewing work on top of the High Flux Isotope Reactor (HFIR) cooling tower. Radiation surveys identified ^{90}Sr on the roofs of older buildings at the HFIR site. Since no ^{90}Sr was found on buildings built between 1988 and 1990, the ^{90}Sr was thought to have been deposited prior to 1988. Later in 1992, beta particles were identified on a bulldozer that had been used in a wooded area southwest of the Health Physics Research Reactor (HPRR) Access Road. More recently in April 1995, ^{90}Sr particles were identified on the top side of ceiling tiles in the overhead area of a building in the HFIR Complex. Considering that the proposed SWSA 7 site was located between the HFIR complex and the HPRR Access Road, it was deemed prudent to investigate the possibility that beta particles might also be present at the SWSA 7 site. A possible explanation for the presence of these particles has been provided by long-time ORNL employees and retirees. Strontium-90 as the titanate was developed in the early 1960s as part of the Systems for Nuclear Auxiliary Power (SNAP) Program. Strontium titanate ($^{90}SrTiO_3$) was produced at the Fission Product Development Laboratory (Building 3517) in the ORNL main plant area. Waste from the process was loaded into a 1-in. lead-lined dumpster, which was transferred to SWSA 5 where it was dumped into a trench. Dumping allowed some articles to become airborne.

29032 (SAND–94-0890) **A sensitivity analysis of the WIPP disposal room model: Phase 1.** Labreche, D.A. (RE/SPEC, Inc., Albuquerque, NM (United States)); Beikmann, M.A.; Osnes, J.D.; Butcher, B.M. Sandia National Labs., Albuquerque, NM (United States). Jul 1995. 321p. Sponsored by USDOE, Washington, DC (United States). DOE Contract AC04-94AL85000. Order Number DE95016749. Source: OSTI; NTIS; INIS; GPO Dep.

The WIPP Disposal Room Model (DRM) is a numerical model with three major components constitutive models of TRU waste, crushed salt backfill, and intact halite – and several secondary components, including air gap elements, slidelines, and assumptions on symmetry and geometry. A sensitivity analysis of the Disposal Room Model was initiated on two of the three major components (waste and backfill models) and on several secondary components as a group. The immediate goal of this component sensitivity analysis (Phase I) was to sort (rank) model parameters in terms of their relative importance to model response so that a Monte Carlo analysis on a reduced set of DRM parameters could be performed under Phase II. The goal of the Phase II analysis will be to develop a probabilistic definition of a disposal room porosity surface (porosity, gas volume, time) that could be used in WIPP Performance Assessment analyses. This report documents a literature survey which quantifies the relative importance of the secondary room components to room closure, a differential analysis of the creep consolidation model and definition of a follow-up Monte Carlo analysis of the model, and an analysis and refitting of the waste component data on which a volumetric plasticity model of TRU drum waste is based. A summary, evaluation of progress, and recommendations for future work conclude the report.

29033 (SAND–94-1376) **WIPP Benchmark calculations with the large strain SPECTROM codes.** Callahan, G.D. (RE/SPEC, Inc., Rapid City, SD (United States)); DeVries, K.L. Sandia National Labs., Albuquerque, NM (United States); RE/SPEC, Inc., Rapid City, SD (United States). Aug 1995. 98p. Sponsored by USDOE, Washington, DC (United States). DOE Contract AC04-94AL85000. Order Number DE95016954. Source: OSTI; NTIS; INIS; GPO Dep.

This report provides calculational results from the updated Lagrangian structural finite-element programs SPECTROM-32 and SPECTROM-333 for the purpose of qualifying these codes to perform analyses of structural situations in the Waste Isolation Pilot Plant (WIPP). Results are presented for the Second WIPP Benchmark (Benchmark II) Problems and for a simplified heated room problem used in a parallel design calculation study. The Benchmark II problems consist of an isothermal room problem and a heated room problem. The stratigraphy involves 27 distinct geologic layers including ten clay seams of which four are modeled as frictionless sliding interfaces. The analyses of the Benchmark II problems consider a 10-year simulation period. The evaluation of nine structural codes used in the Benchmark II problems shows that inclusion of finite-strain effects is not as significant as observed for the simplified heated room problem, and a variety of finite-strain and small-strain formulations produced similar results. The simplified heated room problem provides stratigraphic complexity

equivalent to the Benchmark II problems but neglects sliding along the clay seams. The simplified heated problem does, however, provide a calculational check case where the small strain-formulation produced room closures about 20 percent greater than those obtained using finite-strain formulations. A discussion is given of each of the solved problems, and the computational results are compared with available published results. In general, the results of the two SPECTROM large strain codes compare favorably with results from other codes used to solve the problems.

29034 (UCRL-JC–119435-Rev.1) **Site characterization criteria (DOE-STD-1022-94) for natural phenomena hazards at DOE sites. Revision 1.** Chen, J.C.; Ueng, Tzou-Shin; Boissonnade, A.C. Lawrence Livermore National Lab., CA (United States). 23 Mar 1995. 7p. Sponsored by USDOE, Washington, DC (United States). DOE Contract W-7405-ENG-48. (CONF-950740–96-Rev.1: Joint ASME/JSME pressure vessels and piping conference, Honolulu, HI (United States), 23-27 Jul 1995). Order Number DE96000081. Source: OSTI; NTIS; INIS; GPO Dep.

This paper briefly summarizes requirements of site characterization for Natural Phenomena Hazards (NPH) at DOE sites. In order to comply with DOE Order 5480.28, site characterization criteria has been developed to provide site-specific information needed for development of NPH assessment criteria. Appropriate approaches are outlined to ensure that the current state-of-the-art methodologies and procedures are used in the site characterization. General and detailed site characterization requirements are provided in the areas of meteorology, hydrology, geology, seismology and geotechnical studies.

29035 (WHC-EP–0394-10) **Groundwater maps of the Hanford Site, December 1994.** Serkowski, J.A.; Hartman, M.J.; Sweeney, M.D. Westinghouse Hanford Co., Richland, WA (United States). Jun 1995. 46p. Sponsored by USDOE, Washington, DC (United States). DOE Contract AC06-87RL10930. Order Number DE95017147. Source: OSTI; NTIS; INIS; GPO Dep.

This report is a continuation of a series of reports (see Serkowski et al 1994) that the configuration of the uppermost unconfined aquifer beneath the Hanford Site. This series presents the results of the semiannual water level measurement program and the water table maps generated from these measurements. The reports document the changes in the groundwater level at the Hanford Site during the transition from nuclear material production to environmental restoration and remediation. In addition, these reports provide water level data to support the various site characterization and groundwater monitoring programs currently in progress on the Hanford Site.

29036 (WHC-SA–2665) **Modeling groundwater contamination transport for the Hanford Environmental Disposal Facility.** Finfrock, S.H. Westinghouse Hanford Co., Richland, WA (United States). Oct 1994. 13p. Sponsored by USDOE, Washington, DC (United States). DOE Contract AC06-87RL10930. (CONF-950420–31: International conference on mathematics and computations, reactor physics, and environmental analyses, Portland, OR (United States), 30 Apr - 4 may 1995). Order Number DE95015741. Source: OSTI; NTIS; INIS; GPO Dep.

Preliminary groundwater analyses were performed for the Hanford Environmental Restoration Disposal Facility (ERDF) to demonstrate compliance With dose limit performance objectives in DOE Order 5820.2A. These analyses were designed to determine peak radionuclide concentrations in a theoretical drinking-water well 100 m downstream from the facility. The resulting peak concentrations can be used to determine inventory limits for the facility.

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Refer also to citation(s) 28783, 28789, 28791, 28795, 28796, 28797, 28799, 28800, 28810, 28812, 28822, 28824, 28838, 28890, 28909, 28912, 28931, 28942, 28950, 28951, 28953, 28956, 28961, 28969, 28971, 28981, 28988, 28989, 28991, 28992, 29025, 29026, 29135, 29163, 29592, 29835, 29839, 29841, 29842, 29855, 30282, 30288, 30310, 30319, 30321, 30632, 30633, 30635, 30657, 30669, 30696, 30741, 30753, 30764, 30767, 30783, 30826, 30833, 30835

29037 (ANL/CMT-ACL/CP–85701) **Secondary waste minimization in analytical methods.** Green, D.W. (Argonne National Lab., IL (United States). Analytical Chemistry Lab.); Smith, L.L.; Crain, J.S.; Boparai, A.S.; Kiely, J.T.; Yaeger, J.S.; Schilling, J.B. Argonne National Lab., IL (United States). [1995]. 15p. Sponsored by USDOE, Washington, DC (United States). DOE Contract W-31109-ENG-38. (CONF-9507150–3: 11. annual waste testing and quality assurance symposium, Washington, DC (United States), 23-28 Jul 1995). Order Number DE95014093. Source: OSTI; NTIS; INIS; GPO Dep.

The characterization phase of site remediation is an important and costly part of the process. Because toxic solvents and other hazardous materials are used in common analytical methods, characterization is also a source of new waste, including mixed waste. Alternative analytical methods can reduce the volume or form of hazardous waste produced either in the sample preparation step or in the measurement step. The authors are examining alternative methods in the areas of inorganic, radiological, and organic analysis. For determining inorganic constituents, alternative methods were studied for sample introduction into inductively coupled plasma spectrometers. Figures of merit for the alternative methods, as well as their associated waste volumes, were compared with the conventional approaches. In the radiological area, the authors are comparing conventional methods for gross α/β measurements of soil samples to an alternative method that uses high-pressure microwave dissolution. For determination of organic constituents, microwave-assisted extraction was studied for RCRA regulated semivolatile organics in a variety of solid matrices, including spiked samples in blank soil; polynuclear aromatic hydrocarbons in soils, sludges, and sediments; and semivolatile organics in soil. Extraction efficiencies were determined under varying conditions of time, temperature, microwave power, moisture content, and extraction solvent. Solvent usage was cut from the 300 mL used in conventional extraction methods to about 30 mL. Extraction results varied from one matrix to another. In most cases, the microwave-assisted extraction technique was as efficient as the more common Soxhlet or sonication extraction techniques.

29038 (ANL/EA/CP–84187) **Options for improving hazardous waste cleanups using risk-based criteria.** Elcock, D. Argonne National Lab., Washington, DC (United States). [1995]. 16p. Sponsored by USDOE, Washington, DC (United States). DOE Contract W-31-109-ENG-38. (CONF-950646–27: Air and Waste Management Association meeting, San Antonio, TX (United States), 18-23 Jun 1995). Order Number DE95013712. Source: OSTI; NTIS; INIS; GPO Dep.

This paper explores how risk- and technology-based criteria are currently used in the RCRA and CERCLA cleanup programs. It identifies ways in which risk could be further incorporated into RCRA and CERCLA cleanup requirements and the implications of risk-based approaches. The more universal use of risk assessment as embodied in the risk communication and risk improvement bills before Congress is not addressed. Incorporating risk into the laws and regulations governing hazardous waste cleanup, will allow the use of the best scientific information available to further the goal of environmental protection in the United States while containing costs. and may help set an example for other countries that may be developing cleanup programs, thereby contributing to enhanced global environmental management.

29039 (ANL/EAD/TM–21-Draft) **Risk assessment for the offsite transportation of high-level waste for the U.S. Department of Energy Waste Management Programmatic Environmental Impact Statement.** Monette, F.A. (Argonne National Lab., IL (United States). Environmental Assessment Div.); Biwer, B.M.; LePoire, D.J.; Chen, S.Y. Argonne National Lab., IL (United States). Apr 1995. 110p. Sponsored by USDOE, Washington, DC (United States). DOE Contract W-31109-ENG-38. Order Number DE95017827. Source: OSTI; NTIS; INIS; GPO Dep.

This report describes the human health risk assessment conducted for the transportation of high-level waste (HLW) in support of the US Department of Energy Waste Management Programmatic Environmental Impact Statement (WM PEIS). The assessment considers risks to collective populations and individuals under both routine and accident transportation conditions for

truck and rail shipment modes. The report discusses the scope of the HLW transportation assessment, describes the analytical methods used for the assessment, defines the alternatives considered in the WM PEIS, and details important assessment assumptions. Results are reported for four alternatives. In addition, to aid in the understanding and interpretation of the results, specific areas of uncertainty are described, with an emphasis on how the uncertainties may affect comparisons of the alternatives. The number and scope of the WM PEIS HLW alternatives were revised after the preparation of this report. An addendum has been added to make this HLW transportation risk assessment consistent with that presented in the WM PEIS.

29040 (ANL/EAD/TM–23-Draft) **Supplemental information related to risk assessment for the off-site transportation of low-level waste for the U.S. Department of Energy Waste Management Programmatic Environmental Impact Statement.** Monette, F.A. (Argonne National Lab., IL (United States). Environmental Assessment Div.); Biwer, B.M.; LePoire, D.J.; Chen, S.Y. Argonne National Lab., IL (United States). Apr 1995. 481p. Sponsored by USDOE, Washington, DC (United States). DOE Contract W-31109-ENG-38. Order Number DE95017831. Source: OSTI; NTIS; INIS; GPO Dep.

This report presents supplemental information to support the human health risk assessment conducted for the transportation of low-level waste (LLW) in support of the US Department of Energy Waste Management Programmatic Environmental Impact Statement (WM PEIS). Detailed descriptions of the transportation health risk assessment method and results of the assessment are presented in Appendix E of the WM PEIS and are not repeated in this report. This report presents additional information that is not presented in Appendix E but is necessary to conduct the transportation risk assessment for Waste Management (WM) LLW. Included are definitions of the LLW alternatives considered in the WM PEIS, data related to the inventory and to the physical and radiological characteristics of WM LLW, an overview of the risk assessment method, and detailed results of the assessment for each WM LLW case considered.

29041 (ANL/EAD/TM–27-Draft) **Supplemental information related to risk assessment for the off-site transportation of transuranic waste for the U.S. Department of Energy Waste Management Programmatic Environmental Impact Statement.** Monette, F.A.; Biwer, B.M.; LePoire, D.J.; Chen, S.Y. Argonne National Lab., IL (United States). Apr 1995. 120p. Sponsored by USDOE, Washington, DC (United States). DOE Contract W-31109-ENG-38. Order Number DE95017828. Source: OSTI; NTIS; INIS; GPO Dep.

This report presents supplemental information to support the human health risk assessment conducted for the transportation of transuranic waste (TRUW) in support of the US Department of Energy Waste Management Programmatic Environmental Impact Statement (WM PEIS). Detailed descriptions of the transportation health risk assessment method and results of the assessment are presented in Appendix E of the WM PEIS and are not repeated in this report. This report presents additional information that is not presented in Appendix E but is necessary to conduct the transportation risk assessment for Waste Management (WM) contact- and remote-handed (CH and RH) TRUW. Included are definitions of the TRUW alternatives considered in the WM PEIS, data related to the inventory and to the physical and radiological characteristics of CH and RH TRUW, and detailed results of the assessment for each WM TRUW case considered. After preparation of this report, the WM PEIS TRUW alternatives were revised as combinations of the cases presented herein. An addendum has been added to explain the revision and consolidate the impacts for each alternative for the WM PEIS TRUW transportation risk assessment.

29042 (CONF-940815–114) **Uncertainty analysis for low-level radioactive waste disposal performance assessment at Oak Ridge National Laboratory.** Lee, D.W.; Yambert, M.W.; Kocher, D.C. Oak Ridge National Lab., TN (United States). [1994]. 7p. Sponsored by USDOE, Washington, DC (United States). DOE Contract AC05-84OR21400. From International nuclear and hazardous waste management conference; Atlanta, GA (United States); 14-18 Aug 1994. Order Number DE95014030. Source: OSTI; NTIS; INIS; GPO Dep.

A performance assessment of the operating Solid Waste Storage Area 6 (SWSA 6) facility for the disposal of low-level radioactive waste at the Oak Ridge National Laboratory has been prepared to provide the technical basis for demonstrating compliance with the performance objectives of DOE Order 5820.2A, Chapter 111.2 An analysis of the uncertainty incorporated into the assessment was performed which addressed the quantitative uncertainty in the data used by the models, the subjective uncertainty associated with the models used for assessing performance of the disposal facility and site, and the uncertainty in the models used for estimating dose and human exposure. The results of the uncertainty analysis were used to interpret results and to formulate conclusions about the performance assessment. This paper discusses the approach taken in analyzing the uncertainty in the performance assessment and the role of uncertainty in performance assessment.

29043 (DOE/AL/62350–21F-Rev.1) **Remedial Action Plan and Site design for stabilization of the inactive Uranium Mill Tailings sites at Slick Rock, Colorado: Revision 1. Remedial action selection report, Attachment 2, geology report, Attachment 3, ground water hydrology report, Attachment 4, water resources protection strategy. Final.** Jacobs Engineering Group, Inc., Albuquerque, NM (United States); Morrison-Knudsen Corp., San Francisco, CA (United States). Sep 1995. 400p. Sponsored by USDOE, Washington, DC (United States). DOE Contract AC04-91AL62350. Order Number DE96000224. Source: OSTI; NTIS; INIS; GPO Dep.

The Slick Rock uranium mill tailings sites are located near the small community of Slick Rock, in San Miguel County, Colorado. There are two designated Uranium Mill Tailings Remedial Action (UMTRA) Project sites at Slick Rock: the Union Carbide site and the North Continent site. Both sites are adjacent to the Dolores River. The sites contain former mill building concrete foundations, tailings piles, demolition debris, and areas contaminated by windblown and waterborne radioactive materials. The total estimated volume of contaminated materials is approximately 621,000 cubic yards (475,000 cubic meters). In addition to the contamination at the two processing site areas, 13 vicinity properties were contaminated. Contamination associated with the UC and NC sites has leached into ground water. Pursuant to the requirements of the Uranium Mill Tailings Radiation Control Act (UMTRCA) (42 USC §7901 et seq.), the proposed remedial action plan (RAP) will satisfy the final US Environmental Protection Agency (EPA) standards in 40 CFR Part 192 (60 FR 2854) for cleanup, stabilization, and control of the residual radioactive material (RRM) (tailings and other contaminated materials) at the disposal site at Burro Canyon. The requirements for control of the RRM (Subpart A) will be satisfied by the construction of an engineered disposal cell. The proposed remedial action will consist of relocating the uranium mill tailings, contaminated vicinity property materials, demolition debris, and windblown/weaterborne materials to a permanent repository at the Burro Canyon disposal site. The site is approximately 5 road mi (8 km) northeast of the mill sites on land recently transferred to the DOE by the Bureau of Land Management.

29044 (DOE/AL/62350–21F-Rev.1-Attach.) **Uranium Mill Tailings Remedial Action Project (UMTRAP), Slick Rock, Colorado, Revision 1. Bid schedule, special conditions, specifications, and subcontract drawings.** Jacobs Engineering Group, Inc., Albuquerque, NM (United States); Morrison-Knudsen Corp., San Francisco, CA (United States). [1995]. 400p. Sponsored by USDOE, Washington, DC (United States). DOE Contract AC04-91AL62350. Order Number DE96000228. Source: OSTI; NTIS; INIS; GPO Dep.

This volume contains: bidding requirements; terms and conditions; specifications for Division 1 – general requirements; specifications for Division 2 – sitework; specifications for Divisions 5 – metals; subcontract drawings, (general, Union Carbide processing site, North Continent processing site, and Burro Canyon disposal site).

29045 (DOE/AL/62350–21F-Rev.1-Attach.3-App.C) **Remedial Action Plan and Site Design for stabilization of the inactive Uranium Mill Tailings sites at Slick Rock, Colorado: Appendix**

C to Attachment 3, Calculations. Final. Jacobs Engineering Group, Inc., Albuquerque, NM (United States); Morrison-Knudsen Corp., San Francisco, CA (United States). Sep 1995. 400p. Sponsored by USDOE, Washington, DC (United States). DOE Contract AC04-91AL62350. Order Number DE96000227. Source: OSTI; NTIS; INIS; GPO Dep.

This volume contains calculations for: Slick Rock processing sites background ground water quality; Slick Rock processing sites lysimeter water quality; Slick Rock processing sites on-site and downgradient ground water quality; Slick Rock disposal site background water quality; Burro Canyon disposal site, Slick Rock, Colorado, average hydraulic gradients and average liner ground water velocities in the upper, middle, and lower sandstone units of the Burro Canyon formation; Slick Rock–Burro Canyon disposal site, Burro Canyon pumping and slug tests–analyses; water balance and surface contours–Burro Canyon disposal cell; and analytical calculation of drawdown in a hypothetical well completed in the upper sandstone unit of the Burro Canyon formation.

29046 (DOE/AL/62350–21F-Rev.1-Attach.3-App.A) **Remedial Action Plan and Site Design for stabilization of the inactive Uranium Mill Tailings sites at Slick Rock, Colorado: Appendix A to Attachment 3, Tables. Final.** Jacobs Engineering Group, Inc., Albuquerque, NM (United States); Morrison-Knudsen Corp., San Francisco, CA (United States). Sep 1995. 605p. Sponsored by USDOE, Washington, DC (United States). DOE Contract AC04-91AL62350. Order Number DE96000225. Source: OSTI; NTIS; INIS; GPO Dep.

This volume contains tables of data on ground water quality for the study on ground water hydrology, which is attachment 3 of this series of reports.

29047 (DOE/AL/62350–21F-Rev.1-Vol.1) **Uranium Mill Tailings Remedial Action Project (UMTRAP), Slick Rock, Colorado, Revision 1. Volume 1, Calculations, Final design for construction.** Jacobs Engineering Group, Inc., Albuquerque, NM (United States); Morrison-Knudsen Corp., San Francisco, CA (United States). Sep 1995. 300p. Sponsored by USDOE, Washington, DC (United States). DOE Contract AC04-91AL62350. Order Number DE96000229. Source: OSTI; NTIS; INIS; GPO Dep.

Volume one contains calculations for: embankment design–embankment material properties; Union Carbide site–bedrock contours; vicinity properties–origin of contamination; North Continent and Union Carbide sites contaminated materials–excavation quantities; and demolition debris–quantity estimate.

29048 (DOE/AL/62350–21F-Rev.1-Vol.2) **Uranium Mill Tailings Remedial Action Project (UMTRAP), Slick Rock, Colorado, Revision 1. Volume 2, Calculations, Final design for construction.** Jacobs Engineering Group, Inc., Albuquerque, NM (United States); Morrison-Knudsen Corp., San Francisco, CA (United States). Sep 1995. 500p. Sponsored by USDOE, Washington, DC (United States). DOE Contract AC04-91AL62350. Order Number DE96000230. Source: OSTI; NTIS; INIS; GPO Dep.

Volume two contains calculations for: embankment design–slope stability analysis; embankment design–excavation stability; embankment design–settlement and cover cracking analysis; radon barrier design–statistical analysis of ra-226 concentrations for North Continent and Union Carbide sites; radon barrier design–RAECOM input data; radon barrier design–design thickness; and cover design–frost penetration depth.

29049 (DOE/AL/62350–21F-Rev.1-Vol.3) **Uranium Mill Tailings Remedial Action Project (UMTRAP), Slick Rock, Colorado, Revision 1, Volume 3. Calculations, Final design for construction.** Jacobs Engineering Group, Inc., Albuquerque, NM (United States); Morrison-Knudsen Corp., San Francisco, CA (United States). Sep 1995. 400p. Sponsored by USDOE, Washington, DC (United States). DOE Contract AC04-91AL62350. Order Number DE96000231. Source: OSTI; NTIS; INIS; GPO Dep.

Volume three contains calculations for: site hydrology–rainfall intensity, duration, and frequency relations; site hydrology– probable maximum precipitation; erosion protection–rock quality evaluation; erosion protection–embankment top and side slope; erosion protection–embankment toe apron; erosion protection– gradations and layer thicknesses; Union Carbide site–temporary drainage ditch design; Union Carbide site–retention basin sediment volume; Union Carbide site–retention basin sizing; Burro Canyon site temporary drainage–temporary drainage facilities; and Union Carbide site temporary drainage–water balance.

29050 (DOE/AL/62350–21F-Rev.1-Vol.4) **Uranium Mill Tailings Remedial Action Project (UMTRAP), Slick Rock, Colorado, Revision 1, Volume 4. Calculations, Final design for construction.** Jacobs Engineering Group, Inc., Albuquerque, NM (United States); Morrison-Knudsen Corp., San Francisco, CA (United States). Sep 1995. 400p. Sponsored by USDOE, Washington, DC (United States). DOE Contract AC04-91AL62350. Order Number DE96000232. Source: OSTI; NTIS; INIS; GPO Dep.

Volume four contains calculations for: Borrow areas–site evaluation; temporary facilities–material quantities; embankment quantities–excavation and cover materials; Burro Canyon site excavation quantities–rippable and unrippable materials; site restoration–earthwork quantities and seeding; and bid schedule quantities and material balance.

29051 (DOE/AL/62350–65-Rev.1) **Baseline risk assessment of ground water contamination at the uranium mill tailings site near Riverton, Wyoming. Revision 1.** Jacobs Engineering Group, Inc., Albuquerque, NM (United States). Sep 1995. 130p. Sponsored by USDOE, Washington, DC (United States). DOE Contract AC04-91AL62350. Order Number DE96000235. Source: OSTI; NTIS; INIS; GPO Dep.

The Uranium Mill Tailings Remedial Action (UMTRA) Project consists of two phases: the Surface Project and the Ground Water Project. At the UMTRA Project site near Riverton, Wyoming, Surface Project cleanup occurred from 1988 to 1990. Tailings and radioactively contaminated soils and materials were taken from the Riverton site to a disposal cell in the Gas Hills area, about 60 road miles (100 kilometers) to the east. The surface cleanup reduces radon and other radiation emissions and minimizes further ground water contamination. The UMTRA Project's second phase, the Ground Water Project, will evaluate the nature and extent of ground water contamination at the Riverton site that has resulted from the uranium ore processing activities. Such evaluations are used at each site to determine a strategy for complying with UMTRA ground water standards established by the US Environmental Protection Agency (EPA) and if human health risks could result from exposure to ground water contaminated by uranium ore processing. Exposure could hypothetically occur if drinking water were pumped from a well drilled in an area where ground water contamination might have occurred. Human health and environmental risks may also result if people, plants, or animals are exposed to surface water that has mixed with contaminated ground water.

29052 (DOE/AL/62350–70-Rev.1) **Guidance document for preparing water sampling and analysis plans for UMTRA Project sites. Revision 1.** Jacobs Engineering Group, Inc., Albuquerque, NM (United States). Sep 1995. 30p. Sponsored by USDOE, Washington, DC (United States). DOE Contract AC04-91AL62350. Order Number DE96000234. Source: OSTI; NTIS; INIS; GPO Dep.

A water sampling and analysis plan (WSAP) is prepared for each Uranium Mill Tailings Remedial Action (UMTRA) Project site to provide the rationale for routine ground water sampling at disposal sites and former processing sites. The WSAP identifies and justifies the sampling locations, analytical parameters, detection limits, and sampling frequency for the routine ground water monitoring stations at each site. This guidance document has been prepared by the Technical Assistance Contractor (TAC) for the US Department of Energy (DOE). Its purpose is to provide a consistent technical approach for sampling and monitoring activities performed under the WSAP and to provide a consistent format for the WSAP documents. It is designed for use by the TAC in preparing WSAPs and by the DOE, US Nuclear Regulatory Commission, state and tribal agencies, other regulatory agencies, and the public in evaluating the content of WSAPS.

29053 (DOE/AL/62350–87-Rev.1) **UMTRA Project water sampling and analysis plan, Durango, Colorado. Revision 1.** Jacobs Engineering Group, Inc., Albuquerque, NM (United States). Sep 1995. 60p. Sponsored by USDOE, Washington, DC (United

States). DOE Contract AC04-91AL62350. Order Number DE96000239. Source: OSTI; NTIS; INIS; GPO Dep.

Planned, routine ground water sampling activities at the US Department of Energy (DOE) Uranium Mill Tailings Remedial Action (UMTRA) Project site in Durango, Colorado, are described in this water sampling and analysis plan. The plan identifies and justifies the sampling locations, analytical parameters, detection limits, and sampling frequency for the routine monitoring stations at the site. The ground water data are used to characterize the site ground water compliance strategies and to monitor contaminants of potential concern identified in the baseline risk assessment (DOE, 1995a). Regulatory basis for routine ground water monitoring at UMTRA Project sites is derived from the US EPA regulations in 40 CFR Part 192 (1994) and EPA standards of 1995 (60 FR 2854). Sampling procedures are guided by the UMTRA Project standard operating procedures (SOP) (JEG, n.d.), the Technical Approach Document (TAD) (DOE, 1989), and the most effective technical approach for the site.

29054 (DOE/AL/62350–90S) **Supplement to the UMTRA Project water sampling and analysis plan, Ambrosia Lake, New Mexico.** Jacobs Engineering Group, Inc., Albuquerque, NM (United States). Aug 1995. 7p. Sponsored by USDOE, Washington, DC (United States). DOE Contract AC04-91AL62350. Order Number DE96000240. Source: OSTI; NTIS; INIS; GPO Dep.

The Ambrosia Lake Uranium Mill Tailings Remedial Action (UMTRA) Project site is in McKinley County, New Mexico. As part of UMTRA surface remediation, residual radioactive materials were consolidated on the site in a disposal cell that was completed July 1995. The need for ground water monitoring was evaluated and found not to be necessary beyond the completion of the remedial action because the ground water in the uppermost aquifer is classified as limited use.

29055 (DOE/AL/62350–97-Rev.1) **UMTRA project water sampling and analysis plan, Falls City, Texas. Revision 1.** Jacobs Engineering Group, Inc., Albuquerque, NM (United States). Sep 1995. 60p. Sponsored by USDOE, Washington, DC (United States). DOE Contract AC04-91AL62350. Order Number DE96000447. Source: OSTI; NTIS; INIS; GPO Dep.

Planned, routine ground water sampling activities at the US Department of Energy (DOE) Uranium Mill Tailings Remedial Action (UMTRA) Project site near Falls City, Texas, are described in this water sampling and analysis plan (WSAP). The following plan identifies and justifies the sampling locations, analytical parameters, and sampling frequency for the routine monitoring stations at the site. The ground water data are used for site characterization and risk assessment. The regulatory basis for routine ground water monitoring at UMTRA Project sites is derived from the US Environmental Protection Agency (EPA) regulations in 40 CFR Part 192. Sampling procedures are guided by the UMTRA Project standard operating procedures (SOP) (JEG, n.d.), the Technical Approach Document (TAD) (DOE, 1989), and the most effective technical approach for the site. The Falls City site is in Karnes County, Texas, approximately 8 miles [13 kilometers southwest of the town of Falls City and 46 mi (74 km) southeast of San Antonio, Texas. Before surface remedial action, the tailings site consisted of two parcels. Parcel A consisted of the mill site, one mill building, five tailings piles, and one tailings pond south of Farm-to-Market (FM) Road 1344 and west of FM 791. A sixth tailings pile designated Parcel B was north of FM 791 and east of FM 1344.

29056 (DOE/AL/62350–118S) **Supplement to the UMTRA Project water sampling and analysis plan, Mexican Hat, Utah.** Jacobs Engineering Group, Inc., Albuquerque, NM (United States). Sep 1995. 3p. Sponsored by USDOE, Washington, DC (United States). DOE Contract AC04-91AL62350. Order Number DE96000655. Source: OSTI; NTIS; INIS; GPO Dep.

This water sampling and analysis plan (WSAP) supplement supports the regulatory and technical basis for water sampling at the Mexican Hat, Utah, Uranium Mill Tailings Remedial Action (UMTRA) Project site, as defined in the 1994 WSAP document for Mexican Hat (DOE, 1994). Further, the supplement serves to confirm our present understanding of the site relative to the hydrogeology and contaminant distribution as well as our intention to continue to use the sampling strategy as presented in the 1994 WSAP document for Mexican Hat. Ground water and surface water monitoring activities are derived from the US Environmental Protection Agency regulations in 40 CFR Part 192 (1991) and 60 FR 2854 (1995). Sampling procedures are guided by the UMTRA Project standard operating procedures (JEG, n.d.), the Technical Approach Document (DOE, 1989), and the most effective technical approach for the site. Additional site-specific documents relevant to the Mexican Hat site are the Mexican Hat Long-Term Surveillance Plan (currently in progress), and the Mexican Hat Site Observational Work Plan (currently in progress).

29057 (DOE/AL/62350–121-Rev.1) **UMTRA project water sampling and analysis plan, Naturita, Colorado. Revision 1.** Jacobs Engineering Group, Inc., Albuquerque, NM (United States). Sep 1995. 50p. Sponsored by USDOE, Washington, DC (United States). DOE Contract AC04-91AL62350. Order Number DE96000448. Source: OSTI; NTIS; INIS; GPO Dep.

Planned, routine ground water sampling activities for calendar year 1995 to 1997 at the US Department of Energy (DOE) Uranium Mill Tailings Remedial Action (UMTRA) Project site near Naturita, Colorado, are described in this water sampling and analysis plan. The following plan identifies and justifies the sampling locations, analytical parameters, detection limits, sampling frequency, and specific rationale for each routine monitoring station at the site. The regulatory basis for routine ground water monitoring at UMTRA Project sites is derived from the US Environmental Protection Agency (EPA) regulations in 40 CFR Part 192. Sampling procedures are guided by the UMTRA Project standard operating procedures (SOP) (JEG, n.d.), the Technical Approach Document (TAD) (DOE, 1989), and the most effective technical approach for the site.

29058 (DOE/AL/62350–122S) **Supplement to the UMTRA Project water sampling and analysis plan, Monument Valley, Arizona.** Jacobs Engineering Group, Inc., Albuquerque, NM (United States). Sep 1995. 3p. Sponsored by USDOE, Washington, DC (United States). DOE Contract AC04-91AL62350. Order Number DE96000654. Source: OSTI; NTIS; INIS; GPO Dep.

This water sampling and analysis plan (WSAP) supplement supports the regulatory and technical basis for water sampling at the Riverton, Wyoming, Uranium Mill Tailings Remedial Action (UMTRA) Project site, as defined in the 1994 WSAP document for Riverton (DOE, 1994). Further, the supplement serves to confirm the Project's present understanding of the site relative to the hydrogeology and contaminant distribution as well as the intent to continue to use the sampling strategy as presented in the 1994 WSAP document for Riverton. Ground water and surface water monitoring activities are derived from the US Environmental Protection Agency regulations in 40 CFR Part 192 and 60 FR 2854. Sampling procedures are guided by the UMTRA Project standard operating procedures (JEG, n.d.), the Technical Approach Document (DOE, 1989), and the most effective technical approach for the site. Additional site-specific documents relevant to the Riverton site are the Riverton Baseline Risk Assessment (BLRA) (DOE, 1995a) and the Riverton Site Observational Work Plan (SOWP) (DOE, 1995b).

29059 (DOE/AL/62350–133-Rev.1-Ver.6) **UMTRA Project water sampling and analysis plan, Grand Junction, Colorado. Revision 1, Version 6.** Jacobs Engineering Group, Inc., Albuquerque, NM (United States). Sep 1995. 30p. Sponsored by USDOE, Washington, DC (United States). DOE Contract AC04-91AL62350. Order Number DE96000691. Source: OSTI; NTIS; INIS; GPO Dep.

This water sampling and analysis plan describes the planned, routine ground water sampling activities at the Grand Junction US DOE Uranium Mill Tailings Remedial Action (UMTRA) Project site (GRJ-01) in Grand Junction, Colorado, and at the Cheney Disposal Site (GRJ-03) near Grand Junction. The plan identifies and justifies the sampling locations, analytical parameters, detection limits, and sampling frequencies for the routine monitoring stations at the sites. Regulatory basis is in the US EPA regulations in 40 CFR Part 192 (1994) and EPA ground water quality standards of 1995 (60 FR 2854). This plan summarizes results of past water sampling activities, details water sampling activities planned for the next 2 years, and projects sampling activities for the next 5 years.

29060 (DOE/AL/62350–134-Rev.1) **Baseline risk assessment of ground water contamination at the uranium mill tailings site near Salt Lake City, Utah. Revision 1.** Jacobs Engineering Group, Inc., Albuquerque, NM (United States). Sep 1995. 120p. Sponsored by USDOE, Washington, DC (United States). DOE Contract AC04-91AL62350. Order Number DE96000238. Source: OSTI; NTIS; INIS; GPO Dep.

The Uranium Mill Tailings Remedial Action (UMTRA) Project consists of two phases: the first is the Surface Project, and the second is the Ground Water Project. For the UMTRA Project site known as the Vitro site, near Salt Lake City, Utah, Surface Project cleanup occurred from 1985 to 1987. The UMTRA Project's second phase, the Ground Water Project, evaluates the nature and extent of ground water contamination resulting from uranium processing and determines a strategy for ground water compliance with the Environmental Protection Agency (EPA) ground water standards established for the UMTRA Project. A risk assessment is the process of describing a source of contamination and showing how that contamination may reach people and the environment. The amount of contamination people or the environment may be exposed to is calculated and used to characterize the possible health or environmental effects that may result from this exposure. This risk assessment report is the first site-specific document prepared for the UMTRA Ground Water Project at the Vitro site. The results of this report and further site characterization of the Vitro site will be used to determine what is necessary, if anything, to protect human health and the environment while complying with EPA standards.

29061 (DOE/AL/62350–147-Rev.1) **Baseline risk assessment of ground water contamination at the Uranium Mill Tailings Sites near Slick Rock, Colorado. Revision 1.** Jacobs Engineering Group, Inc., Albuquerque, NM (United States). Sep 1995. 200p. Sponsored by USDOE, Washington, DC (United States). DOE Contract AC04-91AL62350. Order Number DE96000662. Source: OSTI; NTIS; INIS; GPO Dep.

Two UMTRA (Uranium Mill Tailings Remedial Action) Project sites are near Slick Rock, Colorado: the North Continent site and the Union Carbide site. Currently, no one uses the contaminated ground water at either site for domestic or agricultural purposes. However, there may be future land development. This risk assessment evaluates possible future health problems associated with exposure to contaminated ground water. Since some health problems could occur, it is recommended that the contaminated ground water not be used as drinking water.

29062 (DOE/AL/62350–175-Rev.1) **Baseline risk assessment of ground water contamination at the uranium mill tailings site near Durango, Colorado. Revision 1.** Jacobs Engineering Group, Inc., Albuquerque, NM (United States). Sep 1995. 150p. Sponsored by USDOE, Washington, DC (United States). DOE Contract AC04-91AL62350. Order Number DE96000237. Source: OSTI; NTIS; INIS; GPO Dep.

For the UMTRA Project site located near Durango, Colorado (the Durango site), the Surface Project cleanup occurred from 1986 to 1991. An evaluation was made to determine whether exposure to ground water contaminated by uranium processing could affect people's health. Exposure could occur from drinking water pumped from a hypothetical well drilled in the contaminated ground water area. In addition, environmental risks may result if plants or animals are exposed to contaminated ground water, or surface water that has mixed with contaminated ground water. This risk assessment report is the first site-specific document prepared for the UMTRA Ground Water Project at the Durango site. The results of this report and further site characterization of the Durango site will be used to determine what is necessary to protect public health and the environment, and to comply with the EPA standards.

29063 (DOE/AL/62350–179-Rev.1) **Baseline risk assessment of ground water contamination at the uranium mill tailings sites near Rifle, Colorado. Revision 1.** Jacobs Engineering Group, Inc., Albuquerque, NM (United States). Aug 1995. 150p. Sponsored by USDOE, Washington, DC (United States). DOE Contract AC04-91AL62350. Order Number DE96000236. Source: OSTI; NTIS; INIS; GPO Dep.

The US Department of Energy (DOE) Uranium Mill Tailings Remedial Action (UMTRA) Project consists of the Surface Project (Phase 1) and the Ground Water Project (Phase 2). Under the UMTRA Surface Project, tailings, radioactive contaminated soil, equipment, and materials associated with the former uranium ore processing sites are placed into disposal cells. The cells are designed to reduce radon and other radiation emissions and to prevent further ground water contamination. The Ground Water Project evaluates the nature and extent of ground water contamination resulting from the uranium ore processing activities. Two UMTRA Project sites are near Rifle, Colorado: the Old Rifle site and the New Rifle site. Surface cleanup at the two sites is under way and is scheduled for completion in 1996. The Ground Water Project is in its beginning stages. A risk assessment identifies a source of contamination, how that contamination reaches people and the environment, the amount of contamination to which people or the environment may be exposed, and the health or environmental effects that could result from that exposure. This report is a site-specific document that will be used to evaluate current and future impacts to the public and the environment from exposure to contaminated ground water. This evaluation and further site characterization will be used to determine if action is needed to protect human health or the environment.

29064 (DOE/AL/62350–194) **Comment and response document for the ground water protection strategy for the Uranium Mill Tailings Site at Green River, Utah.** Jacobs Engineering Group, Inc., Albuquerque, NM (United States). Sep 1995. 19p. Sponsored by USDOE, Washington, DC (United States). DOE Contract AC04-91AL62350. Order Number DE96000657. Source: OSTI; NTIS; INIS; GPO Dep.

The US Department of Energy (DOE) responses to comments from both the US Nuclear Regulatory Commission (NRC) and the state of Utah are provided in this document. The Proposed Ground Water Protection Strategy for the Uranium Mill Tailings Site at Green River, Utah, presents the proposed (modified) ground water protection strategy for the disposal cell at the Green River disposal site for compliance with Subpart A of 40 CFR Part 192. Before the disposal cell was constructed, site characterization was conducted at the Green River Uranium Mill Tailings Remedial Action (UMTRA) Project site to determine an acceptable compliance strategy. Results of the investigation are reported in detail in the final remedial action plan (RAP) (DOE, 1991a). The NRC and the state of Utah have accepted the final RAP. The changes in this document relate only to a modification of the compliance strategy for ground water protection.

29065 (DOE/AL/62350–195) **Baseline risk assessment of ground water contamination at the Uranium Mill Tailings Site near Naturita, Colorado.** Jacobs Engineering Group, Inc., Albuquerque, NM (United States). Aug 1995. 100p. Sponsored by USDOE, Washington, DC (United States). DOE Contract AC04-91AL62350. Order Number DE96000440. Source: OSTI; NTIS; INIS; GPO Dep.

The Uranium Mill Tailings Remedial Action (UMTRA) Project consists of the Surface Project (phase I), and the Ground Water Project (phase II). For the UMTRA Project site located near Naturita, Colorado (the Naturita site), phase I involves the removal of radioactively contaminated soils and materials and their transportation to a disposal site at Union Carbide Corporation's Upper Burbank Repository at Uravan, Colorado, about 13 road miles (mi) (21 kilometers [km]) to the northwest. No uranium mill tailings are involved because the tailings were removed from the Naturita site and placed at Coke Oven, Colorado, during 1977 to 1979. Phase II of the project will evaluate the nature and extent of ground water contamination resulting from uranium processing and its effect on human health or the environment; and will determine site-specific ground water compliance strategies in accordance with the US Environmental Protection Agency (EPA) ground water standards established for the UMTRA Project. Human health risks could occur from drinking water pumped from a hypothetical well drilled in the contaminated ground water area. Environmental risks may result if plants or animals are exposed to contaminated ground water, or surface water that has received contaminated ground water. Therefore, a risk assessment is conducted for the Naturita site. This risk assessment report is the first site-specific document prepared for the Ground Water Project at the Naturita site. What

follows is an evaluation of current and possible future impacts to the public and the environment from exposure to contaminated ground water. The results of this evaluation and further site characterization will be used to determine whether any action is needed to protect human health or the environment.

29066 (DOE/AL/62350–196) **Work plan for monitor well installation water and sediment sample collection aquifer testing and topographic surveying at the Riverton, Wyoming, UMTRA Project Site.** Jacobs Engineering Group, Inc., Albuquerque, NM (United States). Jun 1995. 30p. Sponsored by USDOE, Washington, DC (United States). DOE Contract AC04-91AL62350. Order Number DE96000450. Source: OSTI; NTIS; INIS; GPO Dep.

Investigations conducted during preparation of the site observational work plan (SOWP) at the Uranium Mill Tailings Remedial Action (UMTRA) Project site support a proposed natural flushing ground water compliance strategy, with institutional controls. However, additional site-specific data are needed to reduce uncertainties in order to confirm the applicability and feasibility of this proposed compliance strategy option. This proposed strategy will be analyzed in the site-specific environmental assessment. The purpose of this work plan is to summarize the data collection objectives to fill those data needs, describe the data collection activities that will be undertaken to meet those objectives, and elaborate on the data quality objectives which define the procedures that will be followed to ensure that the quality of these data meet UMTRA Project needs.

29067 (DOE/AL/62350–197) **Comment and response document for the final remedial action plan site design for stabilization of the inactive Uranium Mill Tailings Sites at Slick Rock, Colorado.** Jacobs Engineering Group, Inc., Albuquerque, NM (United States). Sep 1995. 140p. Sponsored by USDOE, Washington, DC (United States). DOE Contract AC04-91AL62350. Order Number DE96000652. Source: OSTI; NTIS; INIS; GPO Dep.

This document consists of comments and responses; the reviewers are the U.S. Nuclear Regulatory Commission (NRC), Colorado Dept. of Public Health and Environment, and the remedial action contractor (RAC).

29068 (DOE/AL/62350–204) **Final audit report of remedial action construction at the UMTRA Project Ambrosia Lake, New Mexico, site.** Jacobs Engineering Group, Inc., Albuquerque, NM (United States). Sep 1995. 30p. Sponsored by USDOE, Washington, DC (United States). DOE Contract AC04-91AL62350. Order Number DE96000216. Source: OSTI; NTIS; INIS; GPO Dep.

The final audit report for remedial action at the Ambrosia Lake, New Mexico, Uranium Mill Tailings Remedial Action (UMTRA) Project site consists of a summary of the radiological surveillances/audits, quality assurance (QA) in-process surveillances, and a QA final closeout inspection performed by the US Department of Energy (DOE) and the Technical Assistance Contractor (TAC). One radiological surveillance and three radiological audits were performed at the Ambrosia Lake site. The surveillance was performed on 12–16 April 1993 (DOE, 1993d). The audits were performed on 26–29 July 1993 (DOE, 1993b); 21–23 March 1994 (DOE, 1994d); and 1–2 August 1994 (DOE, 1994d). The surveillance and audits resulted in 47 observations. Twelve of the observations raised DOE concerns that were resolved on site or through subsequent corrective action. All outstanding issues were satisfactorily closed out on 28 December 1994. The radiological surveillance and audits are discussed in this report. A total of seven QA in-process surveillances were performed at the Ambrosia Lake UMTRA site are discussed. The DOE/TAC Ambrosia Lake final remedial action close-out inspection was conducted on 26 July 1995 (DOE, 1995a). To summarize, a total of 155 observations were noted during DOE/TAC audit and surveillance activities. Follow-up to responses required from the RAC for the DOE/TAC surveillance and audit observations indicated that all issues related to the Ambrosia Lake site were resolved and closed to the satisfaction of the DOE.

29069 (DOE/AL/62350–208) **Public affairs plan.** Jacobs Engineering Group, Inc., Albuquerque, NM (United States). Sep 1995. 20p. Sponsored by USDOE, Washington, DC (United States). DOE Contract AC04-91AL62350. Order Number DE96000233. Source: OSTI; NTIS; INIS; GPO Dep.

The purpose of the Uranium Mill Tailings Remedial Action (UMTRA) Project Public Affairs Plan is to establish goals for the fiscal year (FY) 1996 UMTRA Project public affairs program and to identify specific activities to be conducted during the year. It describes the roles of various agencies involved in the public affairs program and defines the functions of the UMTRA Project Technical Assistance Contractor (TAC) Public Affairs Department. It replaces the FY 1995 Public Affairs Plan (DOE/AL/62350-154). The plan also describes the US Department of Energy's (DOE) plans to keep stakeholders and other members of the public informed about UMTRA Project policies, plans, and activities, and provide opportunities for stakeholders and interested segments of the public to participate in UMTRA Project decision-making processes. The plan applies to the UMTRA Project Team; the DOE Grand Junction Projects Office (GJPO); the DOE Albuquerque Operations Office, Office of Public Affairs (OPA); the TAC; the UMTRA Project Remedial Action Contractor (RAC); and other cooperating agencies.

29070 (DOE/AL/62350–209) **Baseline risk assessment of ground water contamination at the Uranium Mill Tailings Site near Maybell, Colorado.** Jacobs Engineering Group, Inc., Albuquerque, NM (United States). Sep 1995. 35p. Sponsored by USDOE, Washington, DC (United States). DOE Contract AC04-91AL62350. Order Number DE96000449. Source: OSTI; NTIS; INIS; GPO Dep.

The US Department of Energy (DOE) Uranium Mill Tailings Remedial Action (UMTRA) Project consists of the Surface Project (Phase I) and the Ground Water Project (Phase II). Under the UMTRA Surface Project, tailings, radioactive contaminated soil, building foundations, and materials associated with the former processing of uranium ore at UMTRA sites are placed into disposal cells. The cells are designed to reduce radon and other radiation emissions and to prevent further contamination of ground water. One UMTRA Project site is near Maybell, Colorado. Surface cleanup at this site is under way and is scheduled for completion in 1996. The tailings are being stabilized in-place at this site. The disposal area has been withdrawn from public use by the DOE and is referred to as the permanent withdrawal area. The Ground Water Project evaluates the nature and extent of ground water contamination resulting from past uranium ore processing activities. The Ground Water Project at this site is in its beginning stages. This report is a site-specific document that will be used to evaluate current and future potential impacts to the public and the environment from exposure to contaminated ground water. The results of this evaluation and further site characterization will determine whether any action is needed to protect human health or the environment. Currently, no points of exposure (e.g. a drinking water well); and no receptors of contaminated ground water have been identified at the Maybell site. Therefore, there are no current human health and ecological risks associated with exposure to contaminated ground water. Furthermore, if current site conditions and land- and water-use patterns do not change, it is unlikely that contaminated ground water would reach people or the ecological communities in the future.

29071 (DOE/AL/62350–050510.GRNO-Rev.2,Ver.5) **Ground water protection strategy for the Uranium Mill Tailings Site at Green River, Utah. Final, Revision 2, Version 5: Appendix E to the remedial action plan and site design for stabilization of the inactive uranium mill tailings site at Green River, Utah.** Jacobs Engineering Group, Inc., Albuquerque, NM (United States). Sep 1995. 200p. Sponsored by USDOE, Washington, DC (United States). DOE Contract AC04-91AL62350. Order Number DE96000661. Source: OSTI; NTIS; INIS; GPO Dep.

The purpose of this appendix is to provide a ground water protection strategy for the Uranium Mill Tailings Remedial Action (UMTRA) Project disposal site at Green River, Utah. Compliance with the US Environmental Protection Agency (EPA) ground water protection standards will be achieved by applying supplemental standards (40 CFR § 192.22(a); 60 FR 2854) based on the limited use ground water present in the uppermost aquifer that is associated with widespread natural ambient contamination (40 CFR § 192.11(e); 60 FR 2854). The strategy is based on new information, including ground water quality data collected after remedial action

was completed, and on a revised assessment of disposal cell design features, surface conditions, and site hydrogeology. The strategy will result in compliance with Subparts A and C of the EPA final ground water protection standards (60 FR 2854). The document contains sufficient information to support the proposed ground water protection strategy, with monitor well information and ground water quality data included as a supplement. Additional information is available in the final remedial action plan (RAP) (DOE, 1991a), the final completion report (DOE, 1991b), and the long-term surveillance plan (LTSP) (DOE, 1994a).

29072 (DOE/ER–0659T) **Natural and accelerated bioremediation research program plan.** USDOE Office of Energy Research, Washington, DC (United States). Office of Health and Environmental Research. Sep 1995. 126p. Sponsored by USDOE, Washington, DC (United States). Order Number DE96000157. Source: OSTI; NTIS; INIS; GPO Dep.

This draft plan describes a ten-year program to develop the scientific understanding needed to harness and develop natural and enhanced biogeochemical processes to bioremediate contaminated soils, sediments and groundwater at DOE facilities. The Office of Health and Environmental Research (OHER) developed this program plan, with advice and assistance from DOE's Office of Environmental Management (EM). The program builds on OHER's tradition of sponsoring fundamental research in the life and environmental sciences and was motivated by OHER's and Office of Energy Research's (OER's) commitment to supporting DOE's environmental management mission and the belief that bioremediation is an important part of the solution to DOE's environmental problems.

29073 (DOE/ID–10513) **FY-95 technology catalog. Technology development for buried waste remediation.** USDOE Office of Environmental Restoration and Waste Management, Washington, DC (United States). Office of Technology Development. [1995]. 137p. Sponsored by USDOE, Washington, DC (United States). DOE Contract AD07-93ID10513. Order Number DE96001578. Source: OSTI; NTIS; INIS; GPO Dep.

The US Department of Energy's (DOE) Buried Waste Integrated Demonstration (BWID) program, which is now part of the Landfill Stabilization Focus Area (LSFA), supports applied research, development, demonstration, and evaluation of a multitude of advanced technologies dealing with underground radioactive and hazardous waste remediation. These innovative technologies are being developed as part of integrated comprehensive remediation systems for the effective and efficient remediation of buried waste sites throughout the DOE complex. These efforts are identified and coordinated in support of Environmental Restoration (EM-40) and Waste Management (EM-30) needs and objectives. Sponsored by the DOE Office of Technology Development (EM-50), BWID and LSFA work with universities and private industry to develop technologies that are being transferred to the private sector for use nationally and internationally. This report contains the details of the purpose, logic, and methodology used to develop and demonstrate DOE buried waste remediation technologies. It also provides a catalog of technologies and capabilities with development status for potential users. Past FY-92 through FY-94 technology testing, field trials, and demonstrations are summarized. Continuing and new FY-95 technology demonstrations also are described.

29074 (DOE/OR/21400–T492) **Field demonstration of vapor phase TCE bioreactor. Final report.** Oak Ridge National Lab., TN (United States); Envirogen, Inc., Lawrenceville, NJ (United States). 14 Dec 1994. 22p. Sponsored by USDOE, Washington, DC (United States). DOE Contract AC05-84OR21400. Order Number DE96000673. Source: OSTI; NTIS; GPO Dep.

The objective of this Cooperative Research and Development Agreement (CRADA), was to demonstrate the effectiveness of a vapor-phase bioreactor system for the destruction of trichloroethylene (TCE) from contaminated groundwater. A field demonstration was per-formed using groundwater at the Oak Ridge K-25 Site contaminated with a complex mixture of organic chemicals. This site is managed and operated by Martin Marietta Energy Systems, Inc. for the Department of Energy (DOE). Analysis of the data generated during the test can be summarized in three major observations. First, TCE was degraded in the presence of all the organics found in the steam strip condensate. This was observed during treatment of both the steam strip condensate and condensate amended with TCE to increase its concentration relative to the other components. The conclusion that TCE was being biodegraded was supported by performing mass balance control experiments with the reactor and by tracking recalcitrant chemicals also present in the steam stripper condensate. Second, there appeared to be an initial lag period of up to 24 hours before onset of TCE degradation in the reactor. The source of this lag was not determined but could be related to either an acclimation of the microorganisms to other chemicals found in the condensate or reversible inhibitory effects on TCE degradation. The duration of TCE degradative activity was relatively short for only 2 to 5 days. compared to previous demonstrations where TCE was the sole contaminant. However, several of the runs were interrupted due to mechanical and not biological issues. Third, other chemical contaminants were also degraded. by the bacteria used in the vapor phase reactor which is consistent with previous work performed both at ENVIROGEN and elsewhere.

29075 (DOE/ORO–2032) **Pilot-scale treatability testing – Recycle, reuse, and disposal of materials from decontamination and decommissioning activities: Soda blasting demonstration.** Oak Ridge K-25 Site, TN (United States); O'Brien and Gere Engineers, Inc., Syracuse, NY (United States). Aug 1995. 100p. Sponsored by USDOE, Washington, DC (United States). DOE Contract AC05-84OR21400. Order Number DE96001201. Source: OSTI; NTIS; INIS; GPO Dep.

The US Department of Energy (DOE) is in the process of defining the nature and magnitude of decontamination and decommissioning (D and D) obligations at its sites. With disposal costs rising and available storage facilities decreasing, DOE is exploring and implementing new waste minimizing D and D techniques. Technology demonstrations are being conducted by LMES at a DOE gaseous diffusion processing plant, the K-25 Site, in Oak Ridge, Tennessee. The gaseous diffusion process employed at Oak Ridge separated uranium-235 from uranium ore for use in atomic weapons and commercial reactors. These activities contaminated concrete and other surfaces within the plant with uranium, technetium, and other constituents. The objective of current K-25 D and D research is to make available cost-effective and energy-efficient techniques to advance remediation and waste management methods at the K-25 Site and other DOE sites. To support this objective, O'Brien and Gere tested a decontamination system on K-25 Site concrete and steel surfaces contaminated with radioactive and hazardous waste. A scouring system has been developed that removes fixed hazardous and radioactive surface contamination and minimizes residual waste. This system utilizes an abrasive sodium bicarbonate medium that is projected at contaminated surfaces. It mechanically removes surface contamination while leaving the surface intact. Blasting residuals are captured and dissolved in water and treated using physical/chemical processes. Pilot-scale testing of this soda blasting system and bench and pilot-scale treatment of the generated residuals were conducted from December 1993 to September 1994.

29076 (DOE/RL–89-16-Rev.A) **Single-shell tank closure work plan. Revision A.** USDOE Richland Operations Office, WA (United States). Jun 1995. 534p. Sponsored by USDOE, Washington, DC (United States). DOE Contract AC06-87RL10930. Order Number DE96001202. Source: OSTI; NTIS; INIS; GPO Dep.

In January 1994, the Hanford Federal Facility Agreement and Conset Order (Tri-Party Agreement) was amended to reflect a revised strategy for remediation of radioactive waste in underground storage tanks. These amendments include milestones for closure of the single-shell tank (SST) operable units, to be initiated by March 2012 and completed by September 2024. This SST-CWP has been prepared to address the principal topical areas identified in Tri-Party Agreement Milestone M-45-06 (i.e., regulatory pathway, operable unit characterization, waste retrieval, technology development, and a strategy for achieving closure). Chapter 2.0 of this SST-CWP provides a brief description of the environmental setting, SST System, the origin and characteristics of SST waste, and ancillary equipment that will be remediated as part of SST operable unit closure. Appendix 2A provides a description of the hydrogeology of the Hanford Site, including information on the unsaturated sediments

(vadose zone) beneath the 200 Areas Plateau. Chapter 3.0 provides a discussion of the laws and regulations applicable to closure of the SST farm operable units. Chapter 4.0 provides a summary description of the ongoing characterization activities that best align with the proposed regulatory pathway for closure. Chapter 5.0 describes aspects of the SST waste retrieval program, including retrieval strategy, technology, and sequence, potential tank leakage during retrieval, and considerations of deployment of subsurface barriers. Chapter 6.0 outlines a proposed strategy for closure. Chapter 7.0 provides a summary of the programs underway or planned to develop technologies to support closure. Ca. 325 refs.

29077 (DOE/RL–93-54) **Risk evaluation of remedial alternatives for the Hanford Site.** USDOE Richland Operations Office, WA (United States). May 1995. 90p. Sponsored by USDOE, Washington, DC (United States). DOE Contract AC06-93RL12367. Order Number DE95017536. Source: OSTI; NTIS; INIS; GPO Dep.

The document identifies the points in the feasibility studies/corrective measures studies process in Hanford facilites under the Tri-Party Agreement, and the issues to address. This document also introduces semiquantitative and quantitative risk assessment techniques and guidance to ensure that a RERA (remedial alternative) provides an appropriate level of detail.

29078 (DOE/RL–93-64-Rev.3) **Sodium dichromate expedited response action assessment, Revision 3.** USDOE Richland Operations Office, WA (United States). Jun 1995. 40p. Sponsored by USDOE, Washington, DC (United States). DOE Contract AC06-93RL12367. Order Number DE95017352. Source: OSTI; NTIS; GPO Dep.

The U.S. Environmental Protection Agency (EPA) and the Washington State Department of Ecology (Ecology) recommended that the U.S. Department of Energy (DOE) perform an expedited response action (ERA) for the Sodium Dichromate Barrel Disposal Landfill. The ERA lead regulatory agency is Ecology and EPA is the support agency. The ERA was conducted in accordance with the applicable sections of Title 40, Code of Federal Regulations, the Hanford Federal Facility Agreement and Consent Order, the Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA), the Resource Conservation and Recovery Act (RCRA), and the Washington Model Toxics Control Act (MTCA). The ERA was categorized as nontime-critical, which required preparation of an engineering evaluation and cost analysis (EE/CA). The EE/CA, which was included in the proposal, is a rapid, focused evaluation of available technologies using specific screening factors to assess feasibility, appropriateness, and cost. The ERA goal is to reduce the potential for any contaminant migration from the landfill to the soil column, groundwater, and the Columbia River. Because the Sodium Dichromate Barrel Disposal Landfill is the only waste site within the operable unit, the removal action is the final remediation of the 100-IU-4 Operable Unit. This ERA process started in March 1992. The ERA proposal went through a parallel review process with Westinghouse Hanford Company (WHC), DOE Richland Operations Office (RL), EPA, Ecology, and a 30-day public comment period. Ecology and EPA issued an Action Agreement Memorandum in March 1993. The memorandum directed excavation of all anomalies and disposal of the collected materials at the Hanford Site Central Landfill. Primary field activities were completed by the end of April 1993. Final disposal of a minor quantity of hazardous waste was completed in July 1993.

29079 (DOE/RL–93-82) **Limited field investigation report for the 100-FR-1 Operable Unit.** USDOE Richland Operations Office, WA (United States); Bechtel National, Inc., Richland, WA (United States). Sep 1995. 300p. Sponsored by USDOE, Washington, DC (United States). DOE Contract AC06-93RL12367. Order Number DE96000282. Source: OSTI; NTIS; INIS; GPO Dep.

This limited field investigation (LFI) report summarizes the data collection and analysis activities conducted during the 100-FR-1 Source Operable Unit LFI and the associated qualitative risk assessment (QRA), and makes recommendations on the continued candidacy of high-priority sites for interim remedial measures (IRM). The results and recommendations presented in this report are generally independent of future land use scenarios. An LFI is required when existing data are insufficient to formulate a conceptual model and perform a QRA. The purpose of the report is to identify those sites that are recommended to remain as candidates for IRM, provide a preliminary summary of site characterization studies, refine the conceptual model as needed, identify contaminant- and location-specific applicable or relevant and appropriate requirements (ARAR), and provide a qualitative assessment of the risks associated with the sites. This assessment includes consideration of whether contaminant concentrations pose an unacceptable risk that warrants action through IRM. The final decision to conduct an IRM will rely on many factors including risk, ARAR, future land use, point of compliance, time of compliance, a bias-for-action, and the threat to human health and the environment.

29080 (DOE/RL–94-48) **100-KR-4 Operable Unit focused feasibility study.** USDOE Richland Operations Office, WA (United States); Bechtel National, Inc., Richland, WA (United States). Aug 1995. 400p. Sponsored by USDOE, Washington, DC (United States). DOE Contract AC06-93RL12367. Order Number DE95017528. Source: OSTI; NTIS; INIS; GPO Dep.

This focused feasibility study (FFS) presents a detailed analysis of alternatives for an interim remedial measure (IRM) in the 100-KR-4 Operable Unit. The FFS has been conducted as part of the remedial investigation/feasibility study (RI/FS) process included under the Comprehensive Environmental Response, Compensation, and Liability Act of 1980 (CERCLA). The 100-KR-4 Operable Unit includes the groundwater beneath the 100-K Area, which contains the K-East and K-West reactors. These reactors are two of the nine retired production reactors located in the northern portion of the Hanford Site. All of the operable units associated with the retired reactor areas are collectively referred to as the 100 Areas, one of four groupings of waste sites at Hanford that are on the US Environmental Protection Agency (EPA) National Priorities List (NPL) under CERCLA. The 100-KR-4 Operable Unit includes the groundwater beneath waste sites in the 100-K Area. The Columbia River shoreline represents the downgradient boundary. Waste sites in the 100-K Area are grouped into source operable units 100-KR-1 and 100-KR-2. The scope of environmental restoration activities within the 100-KR-4 Operable Unit may be partially controlled by potential adverse impacts in adjacent areas or to receptors outside the Operable Unit. These include groundwater, river water, riverbed sediments, and aquatic biota that may be exposed to contaminants as the result of groundwater flow from the Operable Unit.

29081 (DOE/RL–94-67) **100-HR-3 Operable Unit focused feasibility study.** USDOE Richland Operations Office, WA (United States); Bechtel National, Inc., Richland, WA (United States). Aug 1995. 500p. Sponsored by USDOE, Washington, DC (United States). DOE Contract AC06-93RL12367. Order Number DE95017530. Source: OSTI; NTIS; INIS; GPO Dep.

This Focused Feasibility Study (FFS) report presents a detailed analysis of alternatives for an interim remedial measure (IRM). The IRM addresses groundwater contamination in the 100-HR-3 Operable Unit. The focus of the FFS is chromium, a waste constituent that is transported by groundwater flow from the 100 Areas into the Columbia River. Ecological receptors in the river ecosystem may be exposed to chromium concentrations that exceed criteria established for the protection of aquatic life. The 100-HR-3 Operable Unit includes the groundwater beneath the 100-D/DR and 100-H reactor areas, and the intervening area (600 Area), as bounded by the Columbia River shoreline and the southern extent of the two reactor areas. Environmental restoration activities within the operable unit may be influenced by potential adverse impacts in adjacent areas, including groundwater, river water, riverbed sediments, and aquatic biota that may be exposed to contaminants as the result of groundwater flow from the operable unit. The starting point for selecting remedial alternatives for detailed analysis in the FFS is the 100 Areas Feasibility Study, Phases 1 and 2 (DOE-RL 1994a). This study presents a generalized view of applicable and implementable remedial technologies for contaminants of potential concern that are typical of all 100 Areas operable units. The FFS refines the analysis of remedial technologies for groundwater by incorporating contaminant characteristics and hydrogeologic conditions that are specific to the 100-HR-3 Operable Unit.

29082 (DOE/RL–94-101) **Proposed plan for interim remedial measures at the 100-HR-1 Operable Unit, Hanford Site, Richland, Washington.** USDOE Richland Operations Office, WA

(United States). [1995]. 15p. Sponsored by USDOE, Washington, DC (United States). DOE Contract AC06-93RL12367. Order Number DE95017539. Source: OSTI; NTIS; INIS; GPO Dep.

This proposed plan identifies the preferred alternative for interim remedial measures for remedial action of radioactive liquid waste disposal sites at the 100-HR-1 Operable Unit, located at the Hanford Site. It also summarizes other remedial alternatives evaluated for interim remedial measures in this operable unit. The intent of interim remedial measures is to speed up actions to address contaminated areas that historically received radioactive liquid waste discharges that pose a potential threat to human health and the environment. This proposed plan is being issued by the Washington State Department of Ecology (Ecology), the lead regulatory agency; the US Environmental Protection Agency (EPA), the support regulatory agency; and the US Department of Energy (DOE), the responsible agency. Ecology, EPA, and DOE are issuing this proposed plan as part of their public participation responsibilities under Section 117(a) of the Comprehensive Environmental Response, Compensation and Liability Act (CERCLA), commonly known as the "Superfund Program." The proposed plan is intended to be a fact sheet for public review that (1) briefly describes the remedial alternatives analyzed; (2) proposes a preferred alternative; (3) summarizes the information relied upon to recommend the preferred alternative; and (4) provides a basis for an interim action record of decision (ROD). The preferred alternative presented in this proposed plan is removal, treatment (as appropriate), and disposal of contaminated soil and associated structures. Treatment will be conducted if there is cost benefit.

29083 (DOE/RL–94-119-Rev.1) **Proposed plan for interim remedial measures at the 100-KR-1 Operable Unit. Revision 1.** USDOE Richland Operations Office, WA (United States); Bechtel National, Inc., Richland, WA (United States). Sep 1995. 16p. Sponsored by USDOE, Washington, DC (United States). DOE Contract AC06-93RL12367. Order Number DE96000283. Source: OSTI; NTIS; INIS; GPO Dep.

This proposed plan identifies the preferred alternative for interim remedial measures for remedial action of radioactive liquid waste disposal sites that include contaminated soils and structures at the 100-KR-1 Operable Unit, located at the Hanford Site. It also summarizes other remedial alternatives evaluated for interim remedial measures in this Operable Unit. The intent of interim remedial measures is to speed up actions to address contaminated areas that pose potential threats to human health and the environment. This proposed plan is being issued by the US Environmental Protection Agency (EPA), the lead regulatory agency; the Washington State Department of Ecology (Ecology), the support regulatory agency; and the US Department of Energy (DOE), the responsible agency. The EPA, Ecology, and the DOE are issuing this proposed plan as part of their public participation responsibilities under Section 117(a) of the Comprehensive Environmental Response, Compensation and Liability Act (CERCLA), commonly known as the "Superfund Law." This proposed plan is intended to be a fact sheet for public review which briefly describes the remedial alternatives analyzed, identifies a preferred alternative, and summarizes the information relied upon to recommend the preferred alternative.

29084 (DOE/RL–95-46) **Soil washing pilot plant treatability test for the 100-DR-1 Operable Unit.** USDOE Richland Operations Office, WA (United States); Bechtel National, Inc., Richland, WA (United States). Sep 1995. 150p. Sponsored by USDOE, Washington, DC (United States). DOE Contract AC06-93RL12367. Order Number DE96000281. Source: OSTI; NTIS; INIS; GPO Dep.

Large volumes of radionuclide contaminated soils remain as a result of past waste disposal practices at the Hanford Site. The amount of contaminated soils requiring remediation in the 100 Area could reach upwards of 10 million yd^3. The proposed plans for the first three source operable units (HR-1, BC-1, DR-1) describe the preferred remediation alternative as remove, treat "as appropriate" and dispose. Soil washing is an alternative that offers an appropriate treatment at a cost comparable to direct disposal. It is an alternative that reduces the problem through treatment, not just moves it to another location. This remediation approach is consistent with the mandate set forth by Congress to treat when possible. Based on results of this and other studies and current knowledge of the soils, soil washing could be applicable to as much as 50% of the contaminated soils in the 100 Area. In addition, one of the recommendations of this report is to continue investigating evolving technologies that could result in further volume reductions and possible recovery of radionuclides for resale.

29085 (DOE/RL–95-56-Rev.2) **100-BC-1 Excavation Demonstration Project Plan. Revision 2.** Bechtel National, Inc., Richland, WA (United States). Sep 1995. 150p. Sponsored by USDOE, Washington, DC (United States). DOE Contract AC06-93RL12367. Order Number DE95017499. Source: OSTI; NTIS; INIS; GPO Dep.

The US Environmental Protection Agency (EPA) and the Washington State Department of Ecology (Ecology) have requested that the US Department of Energy (DOE), through the Environmental Restoration Contractor (ERC), perform removal actions at waste sites within the 100-BC-1 Operable Unit (OU) at the Hanford Site. To accelerate removal actions, the EPA (lead regulatory agency), Ecology (support regulatory agency), and DOE (responsible agency) have chosen an expedited response action (ERA) pathway for these removal actions. These removal actions will be nontime critical, and will follow the applicable sections of 40 CFR 300 Subpart E, and the Comprehensive Environmental Response, Compensation, and Recovery Act of 1980 (CERCLA). The Resource Conservation and Recovery Act of 1976 and the Washington State Model Toxics Control Act Cleanup Regulations (MTCA) are key sources of applicable or relevant and appropriate requirements (ARAR) for the removal actions. Section 7.0 of this plan details the ARARS. This document provides information and guidance on the strategy planned to carry out the removal actions and meet all the project objectives. This document provides the objectives, site selection, subsystems, and phasing (Sections 2.0 through 5.0) of the project. Section 6.0 ties together the previous sections and details the strategy and data needs required to meet the project objectives while performing the removal actions. This strategy is applicable to all sites that will be addressed by this removal action project.

29086 (EGG–11265-1122) **Emergency radiological monitoring and analysis: Federal Radiological Monitoring and Assessment Center.** Thome, D.J. EG and G Energy Measurements, Inc., Las Vegas, NV (United States). [1995]. 5p. Sponsored by USDOE, Washington, DC (United States). DOE Contract AC08-93NV11265. (CONF-950430–13: 5. ANS topical meeting on emergency preparedness and response, Savannah, GA (United States), 18-21 Apr 1995). Order Number DE96000167. Source: OSTI; NTIS; INIS; GPO Dep.

The US Federal Radiological Emergency Response Plan (FRERP) provides the framework for integrating the various Federal agencies responding to a major radiological emergency. The FRERP authorizes the creation of the Federal Radiological Monitoring and Assessment Center (FRMAC), which is established to coordinate all Federal agencies involved in the monitoring and assessment of the off-site radiological conditions in support of the impacted State(s) and the Lead Federal Agency (LFA). Within the FRMAC, the Monitoring and Analysis Division (M&A) is responsible for coordinating all FRMAC assets involved in conducting a comprehensive program of environmental monitoring, sampling, radioanalysis, and quality assurance. To assure consistency, completeness, and the quality of the data produced, a methodology and procedures manual is being developed. This paper discusses the structure, assets, and operations of the FRMAC M&A and the content and preparation of the manual.

29087 (ESH-EMS–940516) **The Savannah River Site's groundwater monitoring program, Third quarter 1994.** Westinghouse Savannah River Co., Aiken, SC (United States). [1995]. 986p. Sponsored by USDOE, Washington, DC (United States). DOE Contract AC09-89SR18035. Order Number DE95017503. Source: OSTI; NTIS; INIS; GPO Dep.

The Environmental Protection Department/Environmental Monitoring Section (EPD/EMS) administers the Savannah River Site's (SRS) Groundwater Monitoring Program. During third quarter 1994, EPD/EMS conducted extensive sampling of monitoring wells. EPD/EMS has established two sets of flagging criteria to assist in managing sample results. The flagging criteria do not define contamination levels; instead, they aid personnel in sample scheduling, data interpretation, and trend identification. Since 1991, the

flagging criteria have been based on the U.S. Environmental Protection Agency (EPA) drinking water standards and on method detection limits. A detailed explanation of the flagging criteria is presented in the Flagging Criteria section of this document. Analytical results from third quarter 1994 are included in this report, which is distributed to all site custodians. Twenty-two wells scheduled for analyses during third quarter 1994 were not sampled pending full establishment of a purge-water containment program. One or more analytes exceeded Flag 2 criteria during third quarter 1994 in 117 monitoring well series. Analytes exceeded the current Flag 2 criteria for the first time since 1984 in 45 of the 117 monitoring well series. Table 1, organized by location, lists those well series with analytes in the groundwater above Flag 2 criteria during third quarter 1994. Results from all laboratory analyses are used to generate this table. Specific conductance and pH data from field measurements also are included in this table.

29088 (FEMP–2362B) **The CAMU Rule: A tool for implementing a protective, cost-effective remedy at the Fernald Environmental Management Project.** Dupuis-Nouille, E.M. (Fernald Environmental Management Project, Cincinnati, OH (United States)); Goidell, L.C.; Strimbu, M.J. Fernald Environmental Restoration Management Corp., Cincinnati, OH (United States). Fernald Environmental Management Project. 1995. 10p. Sponsored by USDOE, Washington, DC (United States). DOE Contract AC24-92OR21972. (CONF-950868–16: Environmental remediation conference: committed to results, Denver, CO (United States), 13-18 Aug 1995). Order Number DE96000318. Source: OSTI; NTIS; INIS; GPO Dep.

The Fernald Environmental Management Project (FEMP) is a former uranium processing facility currently under remediation pursuant to the Comprehensive Environmental Response, Compensation, and Liability Act as amended (CERCLA). Contamination at the FEMP consists of low-level radioactivity, hazardous substances, hazardous wastes and/or mixed wastes. Regulations promulgated under the Resource Conservation and Recovery Act as amended (RCRA) are evaluated as applicable or relevant and appropriate requirements (ARARs) for remediation of the FEMP. Historically, joint CERCLA-RCRA guidance dictated that hazardous waste could not be treated, or moved out of the designated area of contiguous contamination (AOC), without triggering land disposal restrictions (LDRs) or minimum technology requirements (MTRs). To avoid invoking these stringent requirements, in situ capping was chosen as the lower cost remedy at many sites, although on-site disposal and/or treatment of hazardous wastes would have been more protective. The Corrective Action Management Units (CAMUs) and Temporary Units (TUs) Final Rule [58 FR 8658, Vol. 58, No. 29, hereinafter the "CAMU Rule"], promulgated on February 16, 1993, provides facilities regulated under RCRA corrective action authority with greater flexibility to move, treat, and dispose of wastes on site without triggering LDRs or MTRs, thereby encouraging application of innovative technologies and more protective remedies. The waste acceptance criteria for the on-site disposal facility is based on site-specific considerations including the mobility of the contaminants through the underlying site geology and the protectiveness of the engineered liners. Application of the "CAMU Rule" allows for disposition in the on-site facility based on these technical considerations rather than on regulatory classifications.

29089 (FEMP/SUB–095) **Horizontal grout barrier project results of the latest testing.** Riedel, K.W. (PARSONS Environmental Remedial Action Project, Fairfield, OH (United States)); Ridenour, D.E.; Walker, J. Fernald Environmental Restoration Management Corp., Cincinnati, OH (United States). Fernald Environmental Management Project. Mar 1995. 10p. Sponsored by USDOE, Washington, DC (United States). DOE Contract AC24-92OR21972. (CONF-950868–15: Environmental remediation conference: committed to results, Denver, CO (United States), 13-18 Aug 1995). Order Number DE96000317. Source: OSTI; NTIS; INIS; GPO Dep.

Throughout United States Department of Energy (DOE) sites are situations where storage tanks and pits are leaking or have the potential to leak contamination into the soil. Subsequent leaching from rain and groundwater flow disperses the contamination far from the original site and, in some cases, into aquifers which serve as a drinking water source. Fernald Environmental Restoration Management Corporation (FERMCO) at Fernald working with the DOE Office of Technology Development (OTD) and two subcontractors, is pursuing the goal of placing a barrier beneath the contamination to prevent this dispersion. The technology being developed is an in situ approach based on directional drilling and jet grouting techniques developed in the oil fields. The unique barrier techniques being developed depend on innovative tooling and special grouts to install a horizontal barrier underground without disturbing the contaminated soils above. The initial tool designs were tested in December 1992 and were encouraging enough that the DOE agreed to fund continued development. A second set of designs were tested in August 1994. The testing results were less than expected but did provide a number of lessons learned. This paper reports on the third set of tool designs and the results of testing these tools prior to the full demonstration project at Fernald.

29090 (FEMP/SUB–096) **Cost estimating for CERCLA remedial alternatives a unit cost methodology.** Brettin, R.W. (PARSONS Environmental Remedial Action Project, Fairfield, OH (United States)); Carr. D.J.; Janke, R.J. Fernald Environmental Restoration Management Corp., Cincinnati, OH (United States). Fernald Environmental Management Project. Jun 1995. 10p. Sponsored by USDOE, Washington, DC (United States). DOE Contract AC24-92OR21972. (CONF-950868–17: Environmental remediation conference: committed to results, Denver, CO (United States), 13-18 Aug 1995). Order Number DE96000319. Source: OSTI; NTIS; INIS; GPO Dep.

The United States Environmental Protection Agency (EPA) Guidance for Conducting Remedial Investigations and Feasibility Studies Under CERCLA, Interim Final, dated October 1988 (EPA 1988) requires a detailed analysis be conducted of the most promising remedial alternatives against several evaluation criteria, including cost. To complete the detailed analysis, order-of-magnitude cost estimates (having an accuracy of +50 percent to -30 percent) must be developed for each remedial alternative. This paper presents a methodology for developing cost estimates of remedial alternatives comprised of various technology and process options with a wide range of estimated contaminated media quantities. In addition, the cost estimating methodology provides flexibility for incorporating revisions to remedial alternatives and achieves the desired range of accuracy. It is important to note that the cost estimating methodology presented here was developed as a concurrent path to the development of contaminated media quantity estimates. This methodology can be initiated before contaminated media quantities are estimated. As a result, this methodology is useful in developing cost estimates for use in screening and evaluating remedial technologies and process options. However, remedial alternative cost estimates cannot be prepared without the contaminated media quantity estimates. In the conduct of the feasibility study for Operable Unit 5 at the Fernald Environmental Management Project (FEMP), fourteen remedial alternatives were retained for detailed analysis. Each remedial alternative was composed of combinations of remedial technologies and processes which were earlier determined to be best suited for addressing the media-specific contaminants found at the FEMP site, and achieving desired remedial action objectives.

29091 (INEL–95/00080) **Organizational safety factors research lessons learned.** Ryan, T.G. Lockheed Idaho Technologies Co., Idaho Falls, ID (United States). [1995]. 13p. Sponsored by Nuclear Regulatory Commission, Washington, DC (United States). DOE Contract AC07-94ID13223. (CONF-950434–4: International topical meeting on safety culture in nuclear installations, Vienna (Austria), 24-28 Apr 1995). Order Number DE96001626. Source: OSTI; NTIS; INIS; GPO Dep.

This Paper reports lessons learned and state of knowledge gained from an organizational factors research activity involving commercial nuclear power plants in the United States, through the end of 1991, as seen by the scientists immediately involved in the research. Lessons learned information was gathered from the research teams and individuals using a question and answer format. The following five questions were submitted to each team and individual: (1) What organizational factors appear to influence safety performance in some systematic way, (2) Should organizational

factors research focus at the plant level, or should it extend beyond the plant level to the parent company, rate setting commissions, regulatory agencies, (3) How important is having direct access to plants for doing organizational factors research, (4) What lessons have been learned to date as the result of doing organizational factors research in a nuclear regulatory setting, and (5) What organizational research topics and issues should be pursued in the future? Conclusions based on the responses provided for this report are that organizational factors research can be conducted in a regulatory setting and produce useful results. Technologies pioneered in other academic, commercial, and military settings can be adopted for use in a nuclear regulatory setting. The future success of such research depends upon the cooperation of regulators, contractors, and the nuclear industry.

29092 (INEL–95/0182) **HEPA filter leaching concept validation trials at the Idaho Chemical Processing Plant.** Chakravartty, A.C. Lockheed Idaho Technologies Co., Idaho Falls, ID (United States). Apr 1995. 80p. Sponsored by USDOE, Washington, DC (United States). DOE Contract AC07-94ID13223. Order Number DE95017629. Source: OSTI; NTIS; INIS; GPO Dep.

The enclosed report documents six New Waste Calcining Facility (NWCF) HEPA filter leaching trials conducted at the Idaho Chemical Processing Plant using a filter leaching system to validate the filter leaching treatment concept. The test results show that a modified filter leaching system will be able to successfully remove both hazardous and radiological constituents to RCRA disposal levels. Based on the success of the filter leach trials, the existing leaching system will be modified to provide a safe, simple, effective, and operationally flexible filter leaching system.

29093 (INEL–95/0274) **Idaho National Engineering Laboratory radiological control performance indicator report. Second quarter - calendar year 1995.** Aitken, S.B. EG and G Idaho, Inc., Idaho Falls, ID (United States). Aug 1995. 100p. Sponsored by USDOE, Washington, DC (United States). DOE Contract AC07-94ID13223. Order Number DE96001366. Source: OSTI; NTIS; GPO Dep.

This document provides a report and analysis of the Radiological Control Program through the second quarter of 1995 at the Idaho National Engineering Laboratory. It includes basic exposure and contamination numbers, a summary of Radiological Control Performance Indicators and of the criteria for the same.

29094 (INEL–95/0422) **Idaho Chemical Processing Plant failure rate database.** Alber, T.G.; Hunt, C.R.; Fogarty, S.P.; Wilson, J.R. EG and G Idaho, Inc., Idaho Falls, ID (United States). Aug 1995. 70p. Sponsored by USDOE, Washington, DC (United States). DOE Contract AC07-94ID13223. Order Number DE96001367. Source: OSTI; NTIS; INIS; GPO Dep.

This report represents the first major upgrade to the Idaho Chemical Processing Plant (ICPP) Failure Rate Database. This upgrade incorporates additional site-specific and generic data while improving on the previous data reduction techniques. In addition, due to a change in mission at the ICPP, the status of certain equipment items has changed from operating to standby or off-line. A discussion of how this mission change influenced the relevance of failure data also has been included. This report contains two data sources: the ICPP Failure Rate Database and a generic failure rate database. A discussion is presented on the approaches and assumptions used to develop the data in the ICPP Failure Rate Database. The generic database is included along with a short discussion of its application. A brief discussion of future projects recommended to strengthen and lend credibility to the ICPP Failure Rate Database also is included.

29095 (LA-SUB–95-142) **Event group importance measures for top event frequency analyses.** Los Alamos National Lab., NM (United States); New Mexico Univ., Albuquerque, NM (United States). 31 Jul 1995. 74p. Sponsored by USDOE, Washington, DC (United States). DOE Contract W-7405-ENG-36. Order Number DE96000103. Source: OSTI; NTIS; INIS; GPO Dep.

Three traditional importance measures, risk reduction, partial derivative, nd variance reduction, have been extended to permit analyses of the relative importance of groups of underlying failure rates to the frequencies of resulting top events. The partial derivative importance measure was extended by assessing the contribution of a group of events to the gradient of the top event frequency. Given the moments of the distributions that characterize the uncertainties in the underlying failure rates, the expectation values of the top event frequency, its variance, and all of the new group importance measures can be quantified exactly for two familiar cases: (1) when all underlying failure rates are presumed independent, and (2) when pairs of failure rates based on common data are treated as being equal (totally correlated). In these cases, the new importance measures, which can also be applied to assess the importance of individual events, obviate the need for Monte Carlo sampling. The event group importance measures are illustrated using a small example problem and demonstrated by applications made as part of a major reactor facility risk assessment. These illustrations and applications indicate both the utility and the versatility of the event group importance measures.

29096 (LA-UR–95-2084) **Lessons learned from occurrences involving procedures at Los Alamos National Laboratory in 1994.** Frostenson, C.K. Los Alamos National Lab., NM (United States). [1995]. 6p. Sponsored by USDOE, Washington, DC (United States). DOE Contract W-7405-ENG-36. (CONF-951092–3: Human Factors and Ergonomics Society meeting, San Diego, CA (United States), 9-13 Oct 1995). Order Number DE95015301. Source: OSTI; NTIS; GPO Dep.

This study used the Department of Energy (DOE) Occurrence Reporting and Processing System (ORPS) data to investigate occurrences reported during one year at Los Alamos National Laboratory (LANL). ORPS provides a centralized database and computerized support for the Collection, distribution, updating, analysis, and validation of information in occurrence reports about abnormal events related to facility operation. Human factors causes for occurrences are not always defined in ORPS. Content analysis of narrative data revealed that 33% of all LANL 1994 adverse operational events have human factors causes related to procedures. Procedure-caused occurrences that resulted in injury to workers, damage to facilities or equipment, or a near-miss are analyzed.

29097 (LA-UR–95-2465) **Lessons learned from decommissioning projects at Los Alamos National Laboratory.** Salazar, M. Los Alamos National Lab., NM (United States). [1995]. 6p. Sponsored by USDOE, Washington, DC (United States). DOE Contract W-7405-ENG-36. (CONF-950868–10: Environmental remediation conference: committed to results, Denver, CO (United States), 13-18 Aug 1995). Order Number DE95016910. Source: OSTI; NTIS; INIS; GPO Dep.

This paper describes lessons learned over the last 20 years from 12 decommissioning projects at Los Alamos National Laboratory. These lessons relate both to overall program management and to management of specific projects during the planning and operations phases. The issues include waste management; the National Environmental Policy Act (NEPA); the Resource Conservation and Recovery Act (RCRA); the Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA); contracting; public involvement; client/customer interface; and funding. Key elements of our approach are to be proactive; follow the observation method; perform field activities concurrently; develop strategies to keep reportable incidents from delaying work; seek and use programs, methods, etc., in existence to shorten learning curves; network to help develop solutions; and avoid overstudying and overcharacterizing. This approach results in preliminary plans that require very little revision before implementation, reasonable costs and schedules, early acquisition of permits and NEPA documents, preliminary characterization reports, and contracting documents. Our track record is good – the last four projects (uranium and plutonium-processing facility and three research reactors) have been on budget and on schedule.

29098 (LBL–36739) **Injectable barriers for waste isolation.** Persoff, P. (Lawrence Berkeley National Lab., CA (United States). Earth Sciences Div.); Finsterle, S.; Moridis, G.J.; Apps, J.; Pruess, K.; Muller, S.J. Lawrence Berkeley Lab., CA (United States). Mar 1995. 11p. Sponsored by USDOE, Washington, DC (United States). DOE Contract AC03-76SF00098. (CONF-950828–19: National heat transfer conference, Portland, OR (United States), 5-9

Aug 1995). Order Number DE96000134. Source: OSTI; NTIS; INIS; GPO Dep.

In this paper the authors report laboratory work and numerical simulation done in support of development and demonstration of injectable barriers formed from either of two fluids: colloidal silica or polysiloxane. Two principal problems addressed here are control of gel time and control of plume emplacement in the vadose zone. Gel time must be controlled so that the viscosity of the barrier fluid remains low long enough to inject the barrier, but increases soon enough to gel the barrier in place. During injection, the viscosity must be low enough to avoid high injection pressures which could uplift or fracture the formation. To test the grout gel time in the soil, the injection pressure was monitored as grouts were injected into sandpacks. When grout is injected into the vadose zone, it slumps under the influence of gravity, and redistributes due to capillary forces as it gels. The authors have developed a new module for the reservoir simulator TOUGH2 to model grout injection into the vadose zone, taking into account the increase of liquid viscosity as a function of gel concentration and time. They have also developed a model to calculate soil properties after complete solidification of the grout. The numerical model has been used to design and analyze laboratory experiments and field pilot tests. The authors present the results of computer simulations of grout injection, redistribution, and solidification.

29099 (MLM-MU–89-62-0007) **Action description memorandum for the FY 1991 line item: Environmental, Safety and Health Upgrades, Phase 3.** Adams, F.S.; Hunter, M.R. EG and G Mound Applied Technologies, Miamisburg, OH (United States). Feb 1989. 5p. Sponsored by USDOE, Washington, DC (United States). DOE Contract AC24-88DP43495. Order Number DE96000797. Source: OSTI; NTIS; GPO Dep.

This ADM documents the evaluation of the potential environmental impact hazards from the Environmental, Safety and Health Upgrades, Phase 3 project.

29100 (MLM-MU–89-63-0006) **Action description memorandum for the FY 1989 line item: Environmental, safety and health upgrades, Phase 2.** Adams, F.S.; Hunter, M.R.; Anderson, C.R. EG and G Mound Applied Technologies, Miamisburg, OH (United States). Mar 1989. 4p. Sponsored by USDOE, Washington, DC (United States). DOE Contract AC24-88DP43495. Order Number DE96000793. Source: OSTI; NTIS; GPO Dep.

This ADM documents the evaluation of the potential environmental impact hazards from the Environmental, Safety and Health Upgrades, Phase 2, project. Environmental, Safety and Health Upgrades, Phase 2, project is a $6,500,000 Line Item project for FY 1989. ES and H Phase 2, is a portion of a continuing effort to protect the environment, neighbors and employees from any adverse effects caused by the development and production missions of EG and G Mound Applied Technologies. The three parts of ES and H Phase 2 include: (A) new piping to separate potable water from domestic and process water; (B) improvements in explosive storage facilities; and (C) upgrades of the fuel oil storage systems, including a new tank, the containment basin, and dike.

29101 (ORNL/ER–325) **Lifecycle baseline summary for ADS 6504IS Isotopes facilities Deactivation Project at Oak Ridge National Laboratory, Oak Ridge, Tennessee.** Oak Ridge National Lab., TN (United States). Aug 1995. 40p. Sponsored by USDOE, Washington, DC (United States). DOE Contract AC05-84OR21400. Order Number DE95017060. Source: OSTI; NTIS; INIS; GPO Dep.

Environmental Restoration Program.

The scope of this Activity Data Sheet (ADS) is to provide a detailed plan for the Isotopes Facilities Deactivation Project (IFDP) at the Oak Ridge National Laboratory (ORNL). This project places the former isotopes production facilities in a safe, stable, and environmentally sound condition suitable for an extended period of minimum surveillance and maintenance (S&M) until the facilities are included in the Decontamination and Decommissioning (D&D) Program. The facilities included within this deactivation project are Buildings 3026-C, 3026-D, 3028, 3029, 3038-AHF, 3038-E, 3038-M, 3047, 3517, 7025, and the Center Circle Facilities (Buildings 3030, 3031, 3032, 3033, 3033-A, 3034, and 3118). The scope of deactivation identified in this Baseline Report include surveillance and maintenance activities for each facility, engineering, contamination control and structural stabilization of each facility, radioluminescent (RL) light removal in Building 3026, re-roofing Buildings 3030, 3118, and 3031, Hot Cells Cleanup in Buildings 3047 and 3517, Yttrium (Y) Cell and Barricades Cleanup in Building 3038, Glove Boxes & Hoods Removal in Buildings 3038 and 3047, and Inventory Transfer in Building 3517. For a detailed description of activities within this Work Breakdown Structure (WBS) element, see the Level 6 and Level 7 Element Definitions in Section 3.2 of this report.

29102 (ORNL/TM–12851) **Cometabolic bioreactor demonstration at the Oak Ridge K-25 Site: Final report.** Lucero, A.J.; Donaldson, T.L.; Jennings, H.L.; Morris, M.I.; Palumbo, A.V.; Herbes, S.E. Oak Ridge National Lab., TN (United States). Aug 1995. 90p. Sponsored by USDOE, Washington, DC (United States). DOE Contract AC05-84OR21400. Order Number DE96000848. Source: OSTI; NTIS; INIS; GPO Dep.

The Oak Ridge National Laboratory (ORNL) conducted a demonstration of cometabolic technology for bioremediation of groundwater contaminated with trichloroethylene (TCE) and other chlorinated solvents. The technology demonstration was located at a seep from the K-1070-C/D Classified Burial Ground at the Oak Ridge K-25 Site. The technology demonstration was designed to evaluate the performance of two different types of cometabolic processes. In both cases, the TCE is cometabolized in the sense that utilization of a different primary substrate is necessary to obtain the simultaneous cometabolism of TCE. Trichloroethylene alone is unable to support growth and maintenance of the microorganisms. Methanotrophic (methane-utilizing) technology was demonstrated first; aromatic-utilizing microorganisms were demonstrated later. The demonstration was based on scaleup of laboratory and bench-scale prototype equipment that was used to establish the technical feasibility of the processes.This report documents the operation of the methanotrophic bioreactor system to treat the seep water at the demonstration site. The initial objectives were to demonstrate stable operation of the bioreactors and associated equipment, including the pretreatment and effluent polishing steps: and evaluate the biodegradation of TCE and other organics in the seep water for the three operating modes–air oxidation pretreatment, steam-stripping pretreatment, and no pretreatment.

29103 (PNL–10363) **Data fusion analysis of a surface direct-current resistivity and well pick data set.** Clayton, E.A.; Lewis, R.E. Pacific Northwest Lab., Richland, WA (United States). Sep 1995. 42p. Sponsored by USDOE, Washington, DC (United States). DOE Contract AC06-76RL01830. Order Number DE96000715. Source: OSTI; NTIS; INIS; GPO Dep.

Pacific Northwest Laboratory (PNL) has been tasked with testing, debugging, and refining the Hanford Site data fusion workstation (DFW), with the assistance of Coleman Research Corporation (CRC), before delivering the DFW to the environmental restoration client at the Hanford Site. Data fusion is the mathematical combination (or fusion) of disparate data sets into a single interpretation. The data fusion software used in this study was developed by CRC. This report discusses the results of evaluating a surface direct-current (dc) resistivity and well-pick data set using two methods: data fusion technology and commercially available software (i.e., RESIX Plus from Interpex Ltd., Golden, Colorado), the conventional method of analysis. The report compares the two technologies; describes the survey, procedures, and results; and includes conclusions and recommendations. The surface dc resistivity and well-pick data set had been acquired by PNL from a study performed in May 1993 at Eielson Air Force Base near Fairbanks, Alaska. The resistivity survey data were acquired to map the top of permafrost in support of a hydrogeologic study. This data set provided an excellent opportunity to test and refine the dc resistivity capabilities of the DFW; previously, the data fusion software was untested on dc resistivity data. The DFW was used to evaluate the dc resistivity survey data and to produce a 3-dimensional earth model of the study area.

29104 (PNL–10601) **Toxicology profiles of chemical and radiological contaminants at Hanford.** Harper, B.L.; Strenge, D.L.; Stenner, R.D.; Maughan, A.D.; Jarvis, M.K. Pacific Northwest Lab., Richland, WA (United States). Jul 1995. 190p. Sponsored by

USDOE, Washington, DC (United States). DOE Contract AC06-76RL01830. Order Number DE96000877. Source: OSTI; NTIS; INIS; GPO Dep.

This document summarizes toxicology information required under Section 3.3 (Toxicity Assessment) of HSRAM, and can also be used to develop the short toxicology profiles required in site assessments (described in HSRAM, Section 3.3.5). Toxicology information is used in the dose-response step of the risk assessment process. The dose-response assessment describes the quantitative relationship between the amount of exposure to a substance and the extent of toxic injury or disease. Data are derived from animal studies or, less frequently, from studies in exposed human populations. The risks of a substance cannot be ascertained with any degree of confidence unless dose-response relations are quantified. This document summarizes dose-response information available from the US Environmental Protection Agency (EPA). The contaminants selected for inclusion in this document represent most of the contaminants found at Hanford (both radiological and chemical), based on sampling and analysis performed during site investigations, and historical information on waste disposal practices at the Hanford Site.

29105 (PNL–10698) **Hanford Site ground-water monitoring for 1994.** Dresel, P.E. (and others); Thorne, P.D.; Luttrell, S.P. Pacific Northwest Lab., Richland, WA (United States). Aug 1995. 370p. Sponsored by USDOE, Washington, DC (United States). DOE Contract AC06-76RL01830. Order Number DE96001345. Source: OSTI; NTIS; INIS; GPO Dep.

Report includes diskette designed to run on IBM PC or compatible equipment.

This report presents the results of the Ground-Water Surveillance Project monitoring for calendar year 1994 on the Hanford Site, Washington. Hanford Site operations from 1943 onward produced large quantities of radiologic and chemical waste that have impacted ground-water quality on the Site. Monitoring of water levels and ground-water chemistry is performed to track the extent of contamination and trends in contaminant concentrations. The 1994 monitoring was also designed to identify emerging ground-water quality problems. The information obtained is used to verify compliance with applicable environmental regulations and to evaluate remedial actions. Data from other monitoring and characterization programs were incorporated to provide an integrated assessment of Site ground-water quality. Additional characterization of the Site's geologic setting and hydrology was performed to support the interpretation of contaminant distributions. Numerical modeling of sitewide ground-water flow also supported the overall project goals. Water-level monitoring was performed to evaluate ground-water flow directions, to track changes in water levels, and to relate such changes to changes in site disposal practices. Water levels over most of the Hanford Site continued to decline between June 1993 and June 1994. These declines are part of the continued response to the cessation of discharge to U Pond and other disposal facilities. The low permeability in this area which enhanced mounding of waste-water discharge has also slowed the response to the reduction of disposal.

29106 (PNL–10715) **Pacific Northwest Laboratory ALARA report for Calendar Year 1994.** Keller, S.L. Pacific Northwest Lab., Richland, WA (United States). Aug 1995. 30p. Sponsored by USDOE, Washington, DC (United States). DOE Contract AC06-76RL01830. Order Number DE96000198. Source: OSTI; NTIS; INIS; GPO Dep.

This report provides summary results of the Calendar Year (CY) 1994 As Low As Reasonably Achievable (ALARA) Program performance at the Pacific Northwest Laboratory (PNL). This report includes data regarding performance in the area of personnel exposures to radiation, skin contaminations, control of contaminated areas, minimization of radioactive waste, and control of radioactive releases. In CY 1994: (1) The collective total effective dose equivalent to PNL employees during 1994 was 55 person-rem. The Field Dosimetry Services of the Radiological Control Department, Technical Support Section, projected that no PNL employee's dose would exceed 2 rem based on dosimeters processed during the year; no worker actually exceeded the projection-by the end of CY 1994. The maximum dose to any individual was 1.11 rem. (2) There were 34 instances of skin and personal-clothing contamination events for PNL employees during 1994. Eighteen of these contamination events occurred at the 324 Building; eleven occurred at the 325 Building; two occurred in the 327 Building; one occurred in the 326 Building; one occurred in the 3708 Building; and one occurred in the RTL Building. (3) PNL facilities contained 12 Airborne Radioactivity Areas, and 60 Contamination Areas and High Contamination Areas. The area of the Airborne Radioactivity Areas was 383 m^2(4125 ft^2). The area of the Contamination Areas was 5290 m^2(56,947 ft^2). The area of the High Contamination Areas was 266 m^2(2863 ft^2). (4) PNL disposed of 10.5 m^3(371 ft^3) of compacted low level waste. Also disposed was 423 m^3 (14,949 ft^3) of noncompacted low level and mixed waste that was not subject to volume reduction. The total radioactivity of the disposed waste was 1217 Ci. (5) PNL facilities released 165.2 Ci of noble gas, 3.0E-5 Ci of airborne particulate radioactive material, and 12.2 Ci of tritium to the environment.

29107 (PNL–10839) **Sitewide feasibility study Eielson Air Force Base, Alaska.** Last, G.V.; Lanigan, D.C.; Josephson, G.B.; Bagaasen, L.M. Pacific Northwest Lab., Richland, WA (United States). Sep 1995. 170p. Sponsored by USDOE, Washington, DC (United States). DOE Contract AC06-76RL01830. Order Number DE96001147. Source: OSTI; NTIS; GPO Dep.

The Sitewide Feasibility Study (FS) is required under the Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA), the National Contingency Plan (NCP), and the Federal Facility Agreement (FFA) for Eielson Air Force Base (AFB). It is based on findings presented in the Sitewide Remedial Investigation (RI) Report (USAF 1995a), and the Sitewide Baseline Risk Assessment (BLRA) Report (USAF 1995b). Under the FFA, 64 potential source areas were placed in one of six operable units, based on similar contaminant and environmental characteristics, or were included for evaluation under a Source Evaluation Report (SER). The sitewide RI was directed at contamination that was not confined to an operable unit (OU) or SER source area. The objectives of the sitewide RI were to: Provide information about site characteristics to support individual OU RI/FS efforts and the sitewide RI/FS, including site hydrogeology and determination of background soil and groundwater characteristics: identify and characterize contamination that is not confined or attributable to a specific source area through sitewide monitoring of groundwater and surface water; evaluate cumulative risks to human health and the environment from contamination on a sitewide basis; and provide a mechanism for continued cohesive sitewide monitoring.

29108 (PNL-SA–26246) **Liquid Effluent Monitoring Program at the Pacific Northwest Laboratory.** Ballinger, M.Y. Pacific Northwest Lab., Richland, WA (United States). May 1995. 7p. Sponsored by USDOE, Washington, DC (United States). DOE Contract AC06-76RL01830. (CONF-9505101–9: Conference on challenges and innovations in the management of hazardous waste, Washington, DC (United States), 10-12 May 1995). Order Number DE95015826. Source: OSTI; NTIS; INIS; GPO Dep.

Pacific Northwest Laboratory (PNL) is conducting a program to monitor the waste water from PNL-operated research and development facilities on the Hanford Site. The purpose of the program is to collect data to assess administrative controls and to determine whether discharges to the process sewer meet sewer criteria. Samples have been collected on a regular basis from the major PNL facilities on the Hanford Site since March 1994. A broad range of analyses has been performed to determine the primary constituents in the liquid effluent. The sampling program is briefly summarized in the paper. Continuous monitoring of pH, conductivity, and flow also provides data on the liquid effluent streams. In addition to sampling and monitoring, the program is evaluating the dynamics of the waste stream with dye studies and is evaluating the use of newer technologies for potential deployment in future sampling/monitoring efforts. Information collected to date has been valuable in determining sources of constituents that may be higher than the Waste Acceptance Criteria (WAC) for the Treated Effluent Disposal Facility (TEDF). This facility treats the waste streams before discharge to the Columbia River.

29109 (PNL-SA–26423) **Chemical process safety management within the Department of Energy.** Piatt, J.A. Pacific

Northwest Lab., Richland, WA (United States). Jul 1995. 6p. Sponsored by USDOE, Washington, DC (United States). DOE Contract AC06-76RL01830. (CONF-9507140–2: 13. annual system safety conference: the hazard control methodologies for the future, San Jose, CA (United States), 12-17 Jul 1995). Order Number DE95016819. Source: OSTI; NTIS; INIS; GPO Dep.

Although the Department of Energy (DOE) is not well known for its chemical processing activities, the DOE does have a variety of chemical processes covered under OSHA's Rule for Process Safety Management of Highly Hazardous Chemicals (the PSM Standard). DOE, like industry, is obligated to comply with the PSM Standard. The shift in the mission of DOE away from defense programs toward environmental restoration and waste management has affected these newly forming process safety management programs within DOE. This paper describes the progress made in implementing effective process safety management programs required by the PSM Standard and discusses some of the trends that have supported efforts to reduce chemical process risks within the DOE. In June of 1994, a survey of chemicals exceeding OSHA PSM or EPA Risk Management Program threshold quantities (TQs) at DOE sites found that there were 22 processes that utilized toxic or reactive chemicals over TQs; there were 13 processes involving flammable gases and liquids over TQs; and explosives manufacturing occurred at 4 sites. Examination of the survey results showed that 12 of the 22 processes involving toxic chemicals involved the use of chlorine for water treatment systems. The processes involving flammable gases and liquids were located at the Strategic Petroleum Reserve and Naval petroleum Reserve sites.

29110 (SAND–94-2019) **Extensions to the integral line-beam method for gamma-ray skyshine analyses.** Shultis, J.K. (Kansas State Univ., Manhattan, KS (United States). Dept. of Nuclear Engineering); Faw, R.E. Sandia National Labs., Albuquerque, NM (United States); Kansas State Univ., Manhattan, KS (United States). Dept. of Nuclear Engineering. Aug 1995. 161p. Sponsored by USDOE, Washington, DC (United States). DOE Contract AC04-94AL85000. Order Number DE95017632. Source: OSTI; NTIS; GPO Dep.

A computationally simple method for estimating gamma-ray skyshine dose rates has been developed on the basis of the line-beam response function. Both Monte Carlo and pointkernel calculations that account for both annihilation and bremsstrahlung were used in the generation of line beam response functions (LBRF) for gamma-ray energies between 10 and 100 MeV. The LBRF is approximated by a three-parameter formula. By combining results with those obtained in an earlier study for gamma energies below 10 MeV, LBRF values are readily and accurately evaluated for source energies between 0.02 and 100 MeV, for source-to-detector distances between 1 and 3000 m, and beam angles as great as 180 degrees. Tables of the parameters for the approximate LBRF are presented. The new response functions are then applied to three simple skyshine geometries, an open silo geometry, an infinite wall, and a rectangular four-wall building. Results are compared to those of previous calculations and to benchmark measurements. A new approach is introduced to account for overhead shielding of the skyshine source and compared to the simplistic exponential-attenuation method used in earlier studies. The effect of the air-ground interface, usually neglected in gamma skyshine studies, is also examined and an empirical correction factor is introduced. Finally, a revised code based on the improved LBRF approximations and the treatment of the overhead shielding is presented, and results shown for several benchmark problems.

29111 (SAND–95-1758) **International technology catalogue: Foreign technologies to support the environmental restoration and waste management needs of the DOE complex.** Matalucci, R.V. (ed.) (Sandia National Labs., Albuquerque, NM (United States). International Programs Dept.); Jimenez, R.D.; Esparza-Baca, C. (ed.). Sandia National Labs., Albuquerque, NM (United States). Jul 1995. 140p. Sponsored by USDOE, Washington, DC (United States). DOE Contract AC04-94AL85000. Order Number DE95017835. Source: OSTI; NTIS; INIS; GPO Dep.

This document represents a summary of 27 foreign-based environmental restoration and waste management technologies that have been screened and technically evaluated for application to the cleanup problems of the Department of Energy (DOE) nuclear weapons complex. The evaluation of these technologies was initiated in 1992 and completed in 1995 under the DOE's International Technology Coordination Program of the Office of Technology Development. A methodology was developed for conducting a country-by-country survey of several regions of the world where specific environmental technology capabilities and market potential were investigated. The countries that were selected from a rank-ordering process for the survey included: then West Germany, the Netherlands, France, Japan, Taiwan, the Czech and Slovak Republics, and the Former Soviet Union. The notably innovative foreign technologies included in this document were screened initially from a list of several hundred, and then evaluated based on criteria that examined for level of maturity, suitability to the DOE needs, and for potential cost effective application at a DOE site. Each of the selected foreign technologies that were evaluated in this effort for DOE application were subsequently matched with site-specific environmental problem units across the DOE complex using the Technology Needs Assessment CROSSWALK Report. For ease of tracking these technologies to site problem units, and to facilitate their input into the DOE EnviroTRADE Information System, they were categorized into the following three areas: (1) characterization, monitoring and sensors, (2) waste treatment and separations, and (3) waste containment. Technical data profiles regarding these technologies include title and description, performance information, development status, key regulatory considerations, intellectual property rights, institute and contact personnel, and references.

29112 (SAND–95-1795) **Glass Formulation and Fabrication Laboratory, Building 864, Hazards assessment document.** Banda, Z.; Wood, C.L. Sandia National Labs., Albuquerque, NM (United States). Aug 1995. 120p. Sponsored by USDOE, Washington, DC (United States). DOE Contract AC04-94AL85000. Order Number DE95017631. Source: OSTI; NTIS; GPO Dep.

The Department of Energy Order 5500.3A requires facility-specific hazards assessments be prepared, maintained, and used for emergency planning purposes. This hazards assessment document describes the chemical and radiological hazards associated with the Glass Formulation and Fabrication Laboratory, Building 864. The entire inventory was screened according to the potential airborne impact to onsite and offsite individuals. The air dispersion model, ALOHA, estimated pollutant concentrations downwind from the source of a release, taking into consideration the toxicological and physical characteristics of the release site, the atmospheric conditions, and the circumstances of the release. The greatest distances at which a postulated facility event will produce consequences exceeding the ERPG-2 threshold is 96 meters. The highest emergency classification is a Site Area Emergency. The Emergency Planning Zone is 100 meters.

29113 (SAND–95-1953) **1994 Site Environmental Report Sandia National Laboratories Albuquerque, New Mexico.** Shyr, L.J. (and others); Wiggins, T.; White, B.B. (eds.). Sandia National Labs., Albuquerque, NM (United States). Sep 1995. 300p. Sponsored by USDOE, Washington, DC (United States). DOE Contract AC04-94AL85000. Order Number DE96001365. Source: OSTI; NTIS; INIS; GPO Dep.

This 1994 report contains data from routine radiological and nonradiological environmental monitoring activities. Summaries of significant environmental compliance programs in progress, such as National Environmental Policy Act documentation, environmental permits, environmental restoration, and various waste management programs for Sandia National Laboratories in Albuquerque, New Mexico, are included. The maximum off-site dose impact from air emissions was calculated to be 1.5×10^{-4} millirem. The total population within a 50-mile radius of Sandia National Laboratories/New Mexico received an estimated collective dose of 0.012 person-rem during 1994 from the laboratories' operations. This report is prepared for the U.S. Department of Energy in compliance with DOE Order 5400.1.

29114 (SAND–95-2258C) **Preliminary analysis of NAPL behavior in soil-heated vapor extraction for in-situ environmental restoration.** Webb, S.W.; Phelan, J.M. Sandia National Labs., Albuquerque, NM (United States). [1995]. 6p. Sponsored by USDOE, Washington, DC (United States). DOE Contract AC04-94AL85000.

(CONF-950828–21: National heat transfer conference, Portland, OR (United States), 5-9 Aug 1995). Order Number DE96000780. Source: OSTI; NTIS; INIS; GPO Dep.

Simulations of soil-heated vapor extraction have been performed to evaluate the NAPL removal performance as a function of borehole vacuum. The possibility of loss of NAPL containment, or NAPL migration into the unheated soil, is also evaluated in the simulations. A practical warning sign indicating migration of NAPL into the unheated zone is discussed.

29115 (SAND–95-2267C) **Proximal potentially seismogenic sources for Sandia National Laboratories, Albuquerque, New Mexico.** Gibson, J.D. Sandia National Labs., Albuquerque, NM (United States). [1995]. 10p. Sponsored by USDOE, Washington, DC (United States). DOE Contract AC04-94AL85000. (CONF-9511128–3: DOE natural phenomena hazards mitigation symposium, Denver, CO (United States), 13-14 Nov 1995). Order Number DE96000706. Source: OSTI; NTIS; INIS; GPO Dep.

Recent geologic and geophysical investigations within the Albuquerque Basin have shed light on the potentially seismogenic sources that might affect Sandia National Laboratories, New Mexico (SNL/NM), a multi-disciplinary research and engineering facility of the US Department of Energy (DOE). This paper presents a summary of potentially seismogenic sources for SNL/NM, emphasizing those sources within approximately 8 kilometers (km) of the site. Several significant faults of the central Rio Grande rift transect SNL/NM. Although progress has been made on understanding the geometry and interactions of these faults, little is known of the timing of most recent movement or on recurrent intervals for these faults. Therefore, whether particular faults or fault sections have been active during the Holocene or even the late Pleistocene is undocumented. Although the overall subdued surface expression of many of these faults suggests that they have low to moderate slip rates, the proximity of these faults to critical (e.g., nuclear) and non-critical (e.g., high-occupancy, multistory office/light lab) facilities at SNL/NM requires their careful examination for evaluation of potential seismic hazard.

29116 (UCRL-ID–113867-95) **LLNL NESHAPs Project 1994 Annual Report.** Surano, K.A. (and others); Biermann, A.H.; Harrach, R.J. Lawrence Livermore National Lab., CA (United States). Jun 1995. 74p. Sponsored by USDOE, Washington, DC (United States). DOE Contract W-7405-ENG-48. Order Number DE95017842. Source: OSTI; NTIS; GPO Dep.

The NESHAPs standared in 40 CFR part 61, Subpart H limites the emission of radionuclides to the ambient air from DOE facilities to levels resulting in an annual effective dose equivalent (EDE) of 10 mrem to any member of the public. The EDEs to the LLNL site-wide maximally exposed member of the public from 1994 operations were: Livermore 0.065 mrem; site 300 - 0.081 mrem. A complete LLNL-wide radionuclide-inventory update was conducted for 1994. Inventory and site-specific meteorological data, together with results from continuous-monitoring systems, were used as inputs to the EPA-approved CAP88-PC air-dispersion/dose-assessment model to calculate the reported EDEs.

29117 (UCRL-JC–120614) **Hydrostratigraphic analysis - The key to cost-effective ground water cleanup at Lawrence Livermore National Laboratory.** Blake, R.G.; Noyes, C.M.; Maley, M.P. Lawrence Livermore National Lab., CA (United States). Jul 1995. 12p. Sponsored by USDOE, Washington, DC (United States). DOE Contract W-7405-ENG-48. (CONF-950868–18: Environmental remediation conference: committed to results, Denver, CO (United States), 13-18 Aug 1995). Order Number DE96000328. Source: OSTI; NTIS; INIS; GPO Dep.

Cost-effective ground water cleanup requires a thorough understanding of the hydrogeologic factors that control the site-specific flow and transport of contaminants in the subsurface. At Lawrence Livermore National Laboratory (LLNL), contaminants are distributed within a thick, complex sequence of alluvial sediments. We have used hydrostratigraphic analysis to divide this sequence into hydrostratigraphic units (HSUs) based on a detailed analysis of chemical, geological, and aquifer test data. HSUs are defined as sedimentary sequences whose permeable layers show evidence of hydraulic communication. In contrast, hydraulic communication between HSUs is restricted across HSU boundaries. HSUs have been a useful management tool for implementing site-wide remediation by improving our ability to identify and target contaminant migration pathways, delineate individual plume geometries, identify the relationship between plumes and source areas, and better define hydraulic capture areas. With a better understanding of LLNL subsurface conditions, we are more effectively implementing remediation plans, improving cleanup time, and reducing overall project costs. Hydrostratigraphic characterization has been instrumental in communicating the contaminant distribution, subsurface flow pathways, and the cleanup approach to the Department of Energy (DOE), regulatory agencies, and the community.

29118 (WHC-MR–0505) **Type C investigation of electrical fabrication projects in ICF Kaiser shops.** Huckfeldt, R.A. Westinghouse Hanford Co., Richland, WA (United States). Jun 1995. 65p. Sponsored by USDOE, Washington, DC (United States). DOE Contract AC06-87RL10930. Order Number DE95015810. Source: OSTI; NTIS; INIS; GPO Dep.

A Type C Investigation Board was convened to investigate an electrical miswiring problem found during the operation of the electrical distribution trailer for the TWRS Rotary Mode Core Sampling Truck #2. The trailer was designed by WHC and fabricated ICF KH on site for use in the Characterization Program. This problem resulted in a serious safety hazard since the support truck frame/chassis became electrically energized. This final report provides results of the "Type C Investigation, Electrical Fabrication Projects in ICF KH Shops, June, 1995." It contains the investigation scope, executive summary, relevant facts, analysis, conclusions and corrective actions. DOE Order 5484.1, "Environmental Protection, Safety and Health Protection Information Reporting Requirements," was followed in preparation of this report. Because the incident was electrical in nature and involved both Westinghouse Hanford Company and ICF Kaiser Hanford organizations, the board included members from both contractors and members with considerable electrical expertise.

29119 (WHC-SD-SNF-DGS–001) **K-Basins design guidelines.** Roe, N.R.; Mills, W.C. Westinghouse Hanford Co., Richland, WA (United States). Jun 1995. 138p. Sponsored by USDOE, Washington, DC (United States). DOE Contract AC06-87RL10930. Order Number DE95015820. Source: OSTI; NTIS; INIS; GPO Dep.

The purpose of the design guidelines is to enable SNF and K Basin personnel to complete fuel and sludge removal, and basin water mitigation by providing engineering guidance for equipment design for the fuel basin, facility modifications (upgrades), remote tools, and new processes. It is not intended to be a purchase order reference for vendors. The document identifies materials, methods, and components that work at K Basins; it also Provides design input and a technical review process to facilitate project interfaces with operations in K Basins. This document is intended to compliment other engineering documentation used at K Basins and throughout the Spent Nuclear Fuel Project. Significant provisions, which are incorporated, include portions of the following: General Design Criteria (DOE 1989), Standard Engineering Practices (WHC-CM-6-1), Engineering Practices Guidelines (WHC 1994b), Hanford Plant Standards (DOE-RL 1989), Safety Analysis Manual (WHC-CM-4-46), and Radiological Design Guide (WHC 1994f). Documents (requirements) essential to the engineering design projects at K Basins are referenced in the guidelines.

29120 (WHC-SP–0671-Rev.3A) **Westinghouse Hanford Company ALARA year-end report, Calendar Year 1994: Revision 3A, Radiological engineering and ALARA.** Berglund, O.D. Westinghouse Hanford Co., Richland, WA (United States). Jun 1995. 63p. Sponsored by USDOE, Washington, DC (United States). DOE Contract AC06-87RL10930. Order Number DE95016343. Source: OSTI; NTIS; INIS; GPO Dep.

It has long been the US Department of Energy's (DOE's) Policy that radiation doses should be maintained as far below the dose limits as is reasonably achievable. This policy, known as the "ALARA Principle of radiation protection," maintains that radiation exposures should be maintained as low as reasonably achievable, taking into account social, technical, economic, practical, and public policy considerations. The ALARA Principle is based on the hypothesis that even very low radiation doses carry some risk. As a result, it is not enough to maintain doses at/or slightly below limits;

the lower the doses, the lower the risks. Because it is not possible to reduce all doses at DOE facilities to zero, economic and social factors must be considered to determine the optimal level of radiation doses. According to the ALARA Principle, if doses are too high, resources should be well spent to reduce them. At some point, the resources being spent to maintain low doses are exactly balanced by the risks avoided. Reducing doses below this point results in a misallocation of resources; the resources could be spent elsewhere and have a greater positive impact on health and safety. The objective of the Westinghouse Hanford Company (WHC) ALARA/ Contamination Control Improvement Project (CCIP) Program is to manage and control exposures (both individual and collective) to the work force, the general public, and the environment to levels as low as is reasonable using the aforementioned ALARA Principle.

29121 (WSRC-TR–95-0012) **Defense-in-depth evaluation for the New Waste Transfer Facility.** Hayes, T.G.; Kelly, J.L. Westinghouse Savannah River Co., Aiken, SC (United States). Jan 1995. 400p. Sponsored by USDOE, Washington, DC (United States). DOE Contract AC09-89SR18035. Order Number DE95017507. Source: OSTI; NTIS; INIS; GPO Dep.

This report fulfills part of the requirements of References 2 and 3 by documenting a Defense-In-Depth evaluation for the New Waste Transfer Facility (NWTF). This evaluation was performed using methodology similar to that used in an evaluation for the Defense Waste Processing Facility (DWPF). It differs because the DWPF evaluation was based on an existing Process Hazards Analysis (PHA) while NWTF's is based on a Preoperational Process Hazards Review (PHR) (Ref. 1). The accidents in the Process Hazards Review (PHR) were reviewed to determine those that might have significant consequences. Significance was based on the findings of the PHR, The facility design was reviewed to determine the Structures, Systems, and Components (SSCs) and administrative controls available before and after each accident. From this was developed a list of the Lines of Defense (LODs) available to contain the hazard associated with the accident. A summary of these LODs is given in Appendix C. Items are tabulated that are suggested for consideration in the functional classification as worker protection items. The specific criteria used in the evaluation is given in the methodology section of this report. The results are documented in Appendices A, B, C, and D.

29122 (WSRC-TR–95-0138-1-Vol.1) **M-area hazardous waste management facility groundwater monitoring and corrective-action report, First quarter 1995, Volume 1.** Westinghouse Savannah River Co., Aiken, SC (United States). May 1995. 600p. Sponsored by USDOE, Washington, DC (United States). DOE Contract AC09-89SR18035. Order Number DE95017509. Source: OSTI; NTIS; INIS; GPO Dep.

This report, in three volumes, describes the ground water monitoring and c corrective-action program at the M-Area Hazardous Waste Management Facility (HWMF) at the Savannah River Site (SRS) during the fourth quarter 1994 and first quarter 1995. Concise description of the program and considerable data documenting the monitoring and remedial activities are included in the document. This is Volume 1 covering the following topics: sampling and results; hydrogeologic assessment; water quality assessment; effectiveness of the corrective-action program; corrective-action system operation and performance; monitoring and corrective-action program assessment; proposed monitoring and corrective-action program modifications. Also included are the following appendicies: A-standards; B-flagging criteria; C-figures; D-monitoring results tables; E-data quality/usability assessment.

29123 (WSRC-TR–95-0138-1-Vol.2) **M-area hazardous waste management facility groundwater monitoring and corrective-action report, First quarter 1995, Volume 2.** Westinghouse Savannah River Co., Aiken, SC (United States). May 1995. 600p. Sponsored by USDOE, Washington, DC (United States). DOE Contract AC09-89SR18035. Order Number DE95017494. Source: OSTI; NTIS; INIS; GPO Dep.

This report, in three volumes, describes the ground water monitoring and corrective-action program at the M-Area Hazardous Waste Management Facility (HWMF) at the Savannah River Site (SRS) during the fourth quarter 1994 and first quarter 1995. Concise description of the program and considerable data documenting the monitoring and remedial activities are included in the document. Appendices in this Volume II include the following: F-time series plots; G-hydrographs; H-CUSUM data.

29124 (WSRC-TR–95-0138-1-Vol.3) **M-area hazardous waste management facility groundwater monitoring and corrective-action report, First quarter 1995, Volume 3.** Westinghouse Savannah River Co., Aiken, SC (United States). May 1995. 68p. Sponsored by USDOE, Washington, DC (United States). DOE Contract AC09-89SR18035. Order Number DE95017495. Source: OSTI; NTIS; INIS; GPO Dep.

This report, in three volumes, describes the ground water monitoring and corrective-action program at the M-Area Hazardous Waste Management Facility (HWMF) at the Savannah River Site (SRS) during the fourth quarter 1994 and first quarter 1995. Concise description of the program and considerable data documenting the monitoring and remedial activities are included in the document. Volume II includes Appendix I - water elevation and iso-concentration contour maps.

29125 (Y/SUB–95-EAQ10C/1/P1) **Calendar Year 1994 Groundwater Quality Report for the Bear Creek Hydrogeologic Regime Y-12 Plant, Oak Ridge, Tennessee.** Oak Ridge National Lab., TN (United States). Feb 1995. 400p. Sponsored by USDOE, Washington, DC (United States). DOE Contract AC05-84OS21400. Order Number DE96000324. Source: OSTI; NTIS; GPO Dep.

This annual groundwater quality report (GWQR) contains groundwater and surface water quality data obtained during the 1994 calendar year (CY) at several hazardous and non-hazardous waste-management facilities associated with the U.S. Department of Energy (DOE) Y-12 Plant located on the DOE Oak Ridge Reservation (ORR) southeast of Oak Ridge, Tennessee. The sites addressed by this document are located in Bear Creek Valley (BCV) west of the Y-12 Plant complex (directions in this report are in reference to the Y-12 administrative grid system) within the Bear Creek Hydrogeologic Regime (Bear Creek Regime), one of three hydrogeologic regimes defined for the purposes of groundwater and surface water quality monitoring at the Y-12 Plant. The Environmental Management Department of the Y-12 Plant Health, Safety, Environment, and Accountability (HSEA) Organization manages the groundwater monitoring activities in the Bear Creek Regime under the auspices of the Y-12 Plant Groundwater Protection Program (GWPP). The purpose of the GWPP is to characterize the hydrogeology and to monitor groundwater quality at the Y-12 Plant and surrounding area to provide for protection of groundwater resources consistent with federal, state, and local requirements and in accordance with DOE Orders and Martin Marietta Energy Systems, Inc. (Energy Systems) corporate policy. The annual GWQR for the Bear Creek Regime is completed in two parts. Part 1 (this report) consists primarily of data appendices and serves as a reference for the groundwater quality data obtained each CY under the lead of the Y-12 Plant GWPP. Part 2 of the report, to be issued mid-year, will contain an evaluation of the data with respect to regime-wide groundwater quality, present the findings and status of ongoing hydrogeologic studies, describe changes in monitoring priorities, and present planned modifications to the groundwater sampling and analysis program for the following CY.

0550 Safeguards, Inspection, and Accountability

Refer also to citation(s) 28863, 28865, 28869, 28870, 28871, 28874, 28877, 28878, 28884, 28888, 28889, 29546, 29548, 29550, 29551, 29556, 29558, 29559, 30203, 30289, 30409, 30570, 31349

29126 (INIS-mf–14576) **The IAEA technical Co-operation a partner in development in Latin America.** El-Saiedi, A. (International Atomic Energy Agency, Vienna (Austria). Div. of Public Information). International Atomic Energy Agency, Vienna (Austria). Div. of Public Information; Comision de Energia Atomica, La Habana (Cuba). 1995. 20p. (CONF-9505292–: Regional seminar on public information of nuclear energy, Habana (Cuba), 17-19 May 1995). Order Number DE96602793. Source: OSTI; NTIS (US Sales Only); INIS.

Each country was to find means of achieving sustainable development, and for this, technology within a framework of regional

and international co-operation are of utmost importance. The IAEA plays a major role in promoting nuclear technologies for development. Highlights of the IAEA's technical cooperation programme are given in this paper.

29127 (LA-SUB–95-137) **Preconceptual ABC design definition and system configuration layout: Appendix A.** Los Alamos National Lab., NM (United States); Barthold Associates, Inc., Knoxville, TN (United States). Mar 1995. 60p. Sponsored by USDOE, Washington, DC (United States). DOE Contract W-7405-ENG-36. Order Number DE95017809. Source: OSTI; NTIS; INIS; GPO Dep.

The mission of the ABC system is to destroy as effectively as possible the fissile material inserted into the core without producing any new fissile material. The contents of this report are as follows: operating conditions for the steam-cycle ABC system; flow rates and component dimensions; drawings of the ABC layout; and impact of core design parameters on containment size.

29128 (LA-UR–95-1660) **Panel on protection and management of plutonium: Subpanel on safeguards and security.** Tape, J.W. Los Alamos National Lab., NM (United States). [1995]. 12p. Sponsored by USDOE, Washington, DC (United States). DOE Contract W-7405-ENG-36. (CONF-9506229–1: Protection and management of plutonium, Philadelphia, PA (United States), 26-30 Jun 1995). Order Number DE95015329. Source: OSTI; NTIS; INIS; GPO Dep.

Nuclear materials safeguards and security systems are described in the context of the nuclear nonproliferation regime. Materials of interest to safeguards, threats, proposals to strengthen International Atomic Energy Agency safeguards, evolving safeguards issues and requirements, system effectiveness, and elements of a global nuclear materials management regime are discussed. Safeguards are seen as an essential element of nuclear materials management, but not a driver for decisions regarding nuclear power or the disposal of excess weapon nuclear materials.

29129 (LA-UR–95-17922, pp. 1-7) **A long view of global plutonium management.** Wagner, R.L. Jr. (Kaman Sciences Corporation, Alexandria, VA (United States)). Los Alamos National Lab., NM (United States). [1995]. (CONF-9407103–: International conference on accelerator-driven transmutation technologies and applications, Las Vegas, NV (United States), 25 Jul - 1 aug 1994). In *AIP conference on accelerator driven transmutation technologies and applications, Los Vegas, Nevada, July 25-29, 1994.* 958p. Order Number DE95014018. Source: OSTI; NTIS; INIS.

Dealing with the large and growing world inventories of fissile materials from all sources is a major part of the long term challenge of limiting the danger from nuclear weapons. Providing clean, safe nuclear power may also be needed to prevent conditions from arising which could lead to large scale nuclear weapon (re)armament. ADTT technologies might reconcile the seeming dilemma of providing nuclear power while maintaining a very low world inventory of nuclear materials which can be used in weapons. This vision for ADTT should be tested in a variety of ways, including comparisons with competing approaches and with other objectives. Such testing is one part of constructing a path for a decades-long, worldwide implementation campaign for ADTT.

29130 (LA-UR–95-17922, pp. 247) **Status of electro-nuclear facilities development in ITEP.** Chuvilo, I.V. (ITEP, Moscow (Russian Federation)). Los Alamos National Lab., NM (United States). [1995]. (CONF-9407103–: International conference on accelerator-driven transmutation technologies and applications, Las Vegas, NV (United States), 25 Jul - 1 aug 1994). In *AIP conference on accelerator driven transmutation technologies and applications, Los Vegas, Nevada, July 25-29, 1994.* 958p. Order Number DE95014018. Source: OSTI; NTIS; INIS.

The concept of plutonium management, both weapon-grade and power, should be developed taking into account the history of previous stages of the nuclear industry and ideas which guided the process of their implementation. Theoretical studies of several versions of a neutron multiplying subcritical system based on thermal and epithermal neutrons are conducted in ITEP. Systems with several neutron multiplying subcritical sections are considered connected by neutron flux propagation from a previous section to subsequent one. This could be implemented by the use of neutron valves separating these sections that permits to decrease the requirements imposed upon proton beam power significantly. Heterogeneous and homogeneous approaches to implementation of such systems are studied. There are many problems associated with nuclear constants and their classification. Measurements are performed of thermal effects in various materials under proton beam irradiation. Problems associated with materials are in the process of investigation too. Joint programs and division of labour should be organized.

29131 (LA-UR–95-17922, pp. 346-362) **Combining a gas turbine modular helium reactor and an accelerator and for near total destruction of weapons grade plutonium.** Baxter, A.M. (General Atomics, San Diego, CA (United States)); Lane, R.K.; Sherman, R. Los Alamos National Lab., NM (United States). [1995]. (CONF-9407103–: International conference on accelerator-driven transmutation technologies and applications, Las Vegas, NV (United States), 25 Jul - 1 aug 1994). In *AIP conference on accelerator driven transmutation technologies and applications, Los Vegas, Nevada, July 25-29, 1994.* 958p. Order Number DE95014018. Source: OSTI; NTIS; INIS.

Fissioning surplus weapons-grade plutonium (WG-Pu) in a reactor is an effective means of rendering this stockpile non-weapons useable. In addition the enormous energy content of the plutonium is released by the fission process and can be captured to produce valuable electric power. While no fission option has been identified that can accomplish the destruction of more than about 70% of the WG-Pu without repeated reprocessing and recycling, which presents additional opportunities for diversion, the gas turbine modular helium-cooled reactor (GT-MHR), using an annular graphite core and graphite inner and outer reflectors combines the maximum plutonium destruction and highest electrical production efficiency and economics in an inherently safe system. Accelerator driven sub-critical assemblies have also been proposed for WG-Pu destruction. These systems offer almost complete WG-Pu destruction, but achieve this goal by using circulating aqueous or molten salt solutions of the fuel, with potential safety implications. By combining the GT-MHR with an accelerator-driven sub-critical MHR assembly, the best features of both systems can be merged to achieve the near total destruction of WG-Pu in an inherently safe, diversion-proof system in which the discharged fuel elements are suitable for long term high level waste storage without the need for further processing. More than 90% total plutonium destruction, and more than 99.9% Pu-239 destruction, could be achieved. The modular concept minimizes the size of each unit so that both the GT-MHR and the accelerator would be straightforward extensions of current technology.

29132 (MLM–3676) **Security guide for subcontractors.** Adams, R.C. EG and G Mound Applied Technologies, Miamisburg, OH (United States). Jan 1991. 40p. Sponsored by USDOE, Washington, DC (United States). DOE Contract AC24-88DP43495. Order Number DE96000791. Source: OSTI; NTIS; GPO Dep.

This security guide of the Department of Energy covers contractor and subcontractor access to DOE and Mound facilities. The topics of the security guide include responsibilities, physical barriers, personnel identification system, personnel and vehicular access controls, classified document control, protecting classified matter in use, storing classified matter repository combinations, violations, security education clearance terminations, security infractions, classified information nondisclosure agreement, personnel security clearances, visitor control, travel to communist-controlled or sensitive countries, shipment security, and surreptitious listening devices.

29133 (MLM-MU–89-63-0002) **Calorimetry Sample Exchange analysis of data report for October–December, 1988.** Lyons, J.E. EG and G Mound Applied Technologies, Miamisburg, OH (United States). [1989]. 61p. Sponsored by USDOE, Washington, DC (United States). DOE Contract AC24-88DP43495. Order Number DE96000795. Source: OSTI; NTIS; GPO Dep.

The goals of the Calorimetry Sample Exchange Program are to: discuss measurement differences; review and improve analytical measurements and methods; discuss new measurement capabilities; provide data to DOE on measurement capabilities to evaluate

shipper-receiver differences; provide characterized or standard materials as necessary for exchange participants; and provide a measurement control program for plutonium analysis. A sample of PuO_2 powder is available at each participating site for NDA measurement, including either or both calorimetry and high-resolution gamma-ray spectroscopy, the elements which are typically combined to provide a calorimetric assay of plutonium. The facilities measure the sample as frequently and to the level of precision which they desire, and then submit the data to the Exchange for analysis. Statistical tests are used to evaluate the data and to determine if there are significant differences from accepted values for the exchange sample or from data previously reported by that facility. This information is presented, in the form of a quarterly report, intended for use by Exchange participants in measurement control programs, or to indicate when bias corrections may be appropriate. No attempt, however, has been made to standardize methods or frequency of data collection, calibration, or operating procedures. Direct comparisons between laboratories may, therefore, be misleading since data have not bee collected to the same precision or for the same time periods. The six participating laboratories are Lawrence Livermore, Los Alamos, MRC-Mound, Westinghouse Hanford, Rocky Flats, and Savannah River.

29134 (PNL–10705-Vol.1) **Special nuclear materials cutoff exercise: Issues and lessons learned. Volume 1: Summary of exercise.** Libby, R.A. (Pacific Northwest Lab., Richland, WA (United States)); Davis, C.; Segal, J.E.; Stanbro, W.D. Pacific Northwest Lab., Richland, WA (United States). Aug 1995. 50p. Sponsored by USDOE, Washington, DC (United States). DOE Contract AC06-76RL01830. Order Number DE95017593. Source: OSTI; NTIS; INIS; GPO Dep.

In a September 1993 address to the United Nations General Assembly, President Clinton announced a new nonproliferation and export control policy that established a framework for US efforts to prevent the proliferation of weapons of mass destruction. The new policy proposed that the US undertake a comprehensive approach to the growing accumulation of fissile material. One of the key elements was for the US to support a special nuclear materials (SNM) multilateral convention prohibiting the production of highly enriched uranium (HEU) or plutonium for nuclear explosives purposes or outside of international safeguards. This policy is often referred to as the President's Cutoff Initiative or the Fissile Material Cutoff Treaty (FMCT). Because both the US Department of Energy (DOE) and foreign reprocessing facilities similar to PUREX will likely to be inspected under a FMCT, the DOE Office of Arms Control and Nonproliferation, Negotiations and Analysis Division (DOE/NN-41) tasked Pacific Northwest Laboratory (PNL) to perform an information gathering exercise, the PUREX Exercise, using the Plutonium-Uranium Extraction (PUREX) Plant located on the Hanford Site in Washington State. PUREX is a former production reactor fuel reprocessing plant currently undergoing a transition to a "decontamination and decommissioning (D&D) ready" mode. The PUREX Exercise was conducted March 29–30, 1994, to examine aspects of the imposition of several possible cutoff regimes and to study verification of non-production of SNM for nuclear weapons purposes or outside of safeguards. A follow-up activity to further examine various additional verification regimes was held at Los Alamos National Laboratory (LANL) on May 10, 1994.

29135 (PNL–10787) **Determination of the radioactive material and plutonium holdup in ducts and piping in the 327 Building.** Haggard, D.L.; Brackenbush, L.W. Pacific Northwest Lab., Richland, WA (United States). Sep 1995. 80p. Sponsored by USDOE, Washington, DC (United States). DOE Contract AC06-76RL01830. Order Number DE96000749. Source: OSTI; NTIS; INIS; GPO Dep.

The 327 Building Post Irradiation Testing Laboratory is used for temporary storage and for destructive and nondestructive examination of irradiated reactor fuels and structural materials. The facility contains 12 shielded hot cells, two water-filled basins, and dry storage. This report describes the measurements performed to determine the radionuclide content and mass of Pu in ducts, filters, and piping in the basement of the 327 Building at the Hanford Site in Washington State. This information is needed to characterize facility radiation levels, to verify compliance with criticality safety specifications, and to allow more accurate nuclear material control using nondestructive assay (NDA) methods. Gamma assay techniques typically employed for NDA analysis were used to determine the gamma-emitting isotopes in the ducts, filters, and piping. Passive neutron counting was selected to estimate the Pu content because high gamma levels from fission and activation products effectively mask any gamma emissions from Pu. A high-purity gamma-ray detector was used to measure the mixed fission and activation radionuclides. A slab neutron detector containing five ^3He proportional counters was used to determine the neutron emission rates and estimate the mass of Pu present. Estimated Pu mass in the basement ductwork and filters is 7.2 grams. The radioactive liquid waste system line has 4.2 grams and Special Environmental Radiometallurgy Facility cell recirculating system contains 8.7 grams in the lower filter housing and associated piping. Total Pu mass holdup estimates range from 20.1 grams, assuming that the Pu is weapons-grade Pu, to a best estimate of 11.0 grams Pu, assuming 11% ^{240}Pu.

29136 (PNL-D–394) **209-E Upgrades.** Merrill, B.J.; DeMyer, J.J. Pacific Northwest Lab., Richland, WA (United States). 4 Feb 1985. 13p. Sponsored by USDOE, Washington, DC (United States). DOE Contract AC06-76RL01830. Order Number DE95012667. Source: OSTI; NTIS; GPO Dep.

Pacific Northwest Laboratory has initiated a review of the Safeguards and Security systems at the Critical Mass Laboratory with regards to determining appropriate upgrading actions that assure that an effective and efficient Safeguards and Security posture consistent with DOE-RL policies, procedures, and priorities is effected. As a result of this review, PNL has concluded that specific upgrades are required at CML that provide a demonstrated enhancement to the overall security posture of the facility and are based upon prudent expenditures of government funds. It was further concluded that additional recommended upgrades provide minimal improvement to the overall security system at a significant outlay of funds.

29137 (SAND–92-0252) **Aerosol formation from high-velocity uranium drops: Comparison of number and mass distributions. Final report.** Rader, D.J.; Benson, D.A. Sandia National Labs., Albuquerque, NM (United States). May 1995. 57p. Sponsored by USDOE, Washington, DC (United States). DOE Contract AC04-94AL85000. Order Number DE96001349. Source: OSTI; NTIS; INIS; GPO Dep.

This report presents the results of an experimental study of the aerosol produced by the combustion of high-velocity molten-uranium droplets produced by the simultaneous heating and electromagnetic launch of uranium wires. These tests are intended to simulate the reduction of high-velocity fragments into aerosol in high-explosive detonations or reactor accidents involving nuclear materials. As reported earlier, the resulting aerosol consists mainly of web-like chain agglomerates. A condensation nucleus counter was used to investigate the decay of the total particle concentration due to coagulation and losses. Number size distributions based on mobility equivalent diameter obtained soon after launch with a Differential Mobility Particle Sizer showed lognormal distributions with an initial count median diameter (CMD) of 0.3 μm and a geometric standard deviation, σ_g of about 2; the CMD was found to increase and σ_g decrease with time due to coagulation. Mass size distributions based on aerodynamic diameter were obtained for the first time with a Microorifice Uniform Deposit Impactor, which showed lognormal distributions with mass median aerodynamic diameters of about 0.5 μm and an aerodynamic geometric standard deviation of about 2. Approximate methods for converting between number and mass distributions and between mobility and aerodynamic equivalent diameters are presented.

29138 (SAND–93-1726/2) **Tamper-indicating devices and safeguards seals evaluation test report. Volume 2.** Horton, P.R.V.; Waddoups, I.G. Sandia National Labs., Albuquerque, NM (United States). Aug 1995. 53p. Sponsored by USDOE, Washington, DC (United States). DOE Contract AC04-94AL85000. Order Number DE96000204. Source: OSTI; NTIS; INIS; GPO Dep.

Volume I was based on a survey and an evaluation of seals that are used as tamper-indicating devices at DOE facilities. For that

evaluation, currently available seals were physically and environmentally evaluated under two broad categories: handling durability and tamper resistance. Our study indicated that the environmental testing had no negative effects on the results of the mechanical tests. In Volume II, we evaluate some loop, fiber optic loop, and pressure-sensitive seals that are not used at DOE facilities. However, we continue to focus on qualities required by DOE: durability and tamper resistance. The seals are comparatively rated, and recommendations are made for using currently available seals and new tamper-indicating device technology.

29139 (SAND–95-1450C) **Safeguards and security issues for the disposition of fissile materials.** Jaeger, C.D. (Sandia National Labs., Albuquerque, NM (United States)); Moya, R.W.; Duggan, R.A.; Mangan, D.L.; Tolk, K.M.; Rutherford, D.; Fearey, B.; Moore, L. Sandia National Labs., Albuquerque, NM (United States). [1995]. 6p. Sponsored by USDOE, Washington, DC (United States). DOE Contract AC04-94AL85000. (CONF-950787–52: 36. annual meeting of the Institute for Nuclear Materials Management, Palm Desert, CA (United States), 9-12 Jul 1995). Order Number DE95014845. Source: OSTI; NTIS; INIS; GPO Dep.

The Department of Energy's Office of Fissile Material Disposition (FMD) is analyzing long-term storage and disposition options for surplus weapons-usable fissile materials, preparing a programmatic environmental impact statement (PEIS), preparing for a record of decision (ROD) regarding this material and conducting other activities. The primary security objectives of this program are to reduce major security risks and strengthen arms reduction and nonproliferation (NP). To help achieve these objectives, a safeguards and security (S&S) team consisting of participants from Sandia, Los Alamos, and Lawrence Livermore National Laboratories was established. The S&S activity for this program is a cross-cutting task which addresses all of the FMD program options. It includes both domestic and international safeguards and includes areas such as physical protection, nuclear materials accountability and material containment and surveillance. This paper will discuss the activities of the Fissile Materials Disposition Program (FMDP) S&S team as well as some specific S&S issues associated with various FMDP options/facilities. Some of the items to be discussed include the threat, S&S requirements, S&S criteria for assessing risk, S&S issues concerning fissile material processing/facilities, and international and domestic safeguards.

29140 (SAND–95-1451C) **New PAMTRAK features.** Dahly, B. (Sandia National Labs., Albuquerque, NM (United States)); Anspach, J. Sandia National Labs., Albuquerque, NM (United States). [1995]. 5p. Sponsored by USDOE, Washington, DC (United States). DOE Contract AC04-94AL85000. (CONF-950787–20: 36. annual meeting of the Institute for Nuclear Materials Management, Palm Desert, CA (United States), 9-12 Jul 1995). Order Number DE95015079. Source: OSTI; NTIS; INIS; GPO Dep.

Sandia is developing a Personnel and Material Tracking System (PAMTRAK) which uses a variety of techniques to monitor material inside a vault in real-time. It can detect material movement using video cameras inside the vault or motion sensors attached to the material. It also contains two prototype attribute monitoring systems that continuously measure material weight, temperature or movement. A site can use any of these alone or together to extend physical inventory intervals. PAMTRAK can reduce the cost of storing material by reducing inventory frequency and radiation exposure to workers. Analysis at Savannah River in 1992 estimated that installing PAMTRAK in the 7 active and future vaults at that site would save $1,073,000 per year by reducing inventory frequency from monthly to yearly. Performing similar calculations now, assuming lower radiation exposure limits of 700m Rem per year, new inventory reduction guidelines allowing a baseline interval of 6 months, and an achieved inventory interval of 3 years, results in an estimated average savings of $400,000 per year. PAMTRAK, since it is real-time, can detect theft or diversion soon enough to give the guard force a chance of recovering the material and apprehending the perpetrator. In performing an inventory a site typically checks only a fraction of the material using random, statistical sampling, while PAMTRAK monitors all material in the vault. In addition to static environments such as vaults, PAMTRAK can be used to protect material in active work areas. Several of the sensor types can ignore activity around material but still report alarms if the material is moved or handled. PAMTRAK includes a personnel tracking capability that allows a site to monitor and restrict personnel movements. It can exclude workers from designated areas unless they have explicit permission to be there. It can also enforce the 2-person rule by requiring a worker to be accompanied by at least one other qualified worker.

29141 (SAND–95-1906) **English/Russian and Russian/English glossary of physical protection terms.** Soo Hoo, M.S. (ed.). Sandia National Labs., Albuquerque, NM (United States). Jul 1995. 103p. Sponsored by USDOE, Washington, DC (United States). DOE Contract AC04-94AL85000. Order Number DE96001327. Source: OSTI; NTIS; INIS; GPO Dep.

This glossary was prepared in fulfillment of the Glossary Preparation Task identified in the Program Plan for providing Assistance to the Russian Federation in Nuclear Material Control and Accounting and Physical Protection. The Program Plan is part of the Cooperative Threat Reduction Program as provided for under House Resolution (H.R.) 3807 (Title II, as referenced under Public Law (P.L.) 102-229. The terms in this glossary were derived from physical protection training material prepared at Sandia. The training material, and thus refinements to the glossary, has undergone years of development in presentation to both domestic and international audiences. Also, Russian Colleagues and interpreters have reviewed the translations for accuracy.

29142 (SAND–95-2012C) **Process of system design and analysis.** Gardner, B. Sandia National Labs., Albuquerque, NM (United States). [1995]. 20p. Sponsored by USDOE, Washington, DC (United States). DOE Contract AC04-94AL85000. (CONF-9509220–2: Workshop on physical protection, Moscow (Russian Federation), 11-14 Sep 1995). Order Number DE95017889. Source: OSTI; NTIS; INIS; GPO Dep.

The design of an effective physical protection system includes the determination of the physical protection system objectives, the initial design of a physical protection system, the evaluation of the design, and, probably, a redesign or refinement of the system. To develop the objectives, the designer must begin by gathering information about facility operations and conditions, such as a comprehensive description of the facility, operating states, and the physical protection requirements. The designer then needs to define the threat. This involves considering factors about potential adversaries: Class of adversary, adversary's capabilities, and range of adversary's tactics. Next, the designer should identify targets. Determination of whether or not nuclear materials are attractive targets is based mainly on the ease or difficulty of acquisition and desirability of the material. The designer now knows the objectives of the physical protection system, that is, "What to protect against whom." The next step is to design the system by determining how best to combine such elements as fences, vaults, sensors, procedures, communication devices, and protective force personnel to meet the objectives of the system. Once a physical protection system is designed, it must be analyzed and evaluated to ensure it meets the physical protection objectives. Evaluation must allow for features working together to assure protection rather than regarding each feature separately. Due to the complexity of protection systems, an evaluation usually requires modeling techniques. If any vulnerabilities are found, the initial system must be redesigned to correct the vulnerabilities and a reevaluation conducted.

29143 (SAND–95-2125C) **Physical protection implementation in the Former Soviet Union.** Williams, J.D. Sandia National Labs., Albuquerque, NM (United States). [1995]. 5p. Sponsored by USDOE, Washington, DC (United States). DOE Contract AC04-94AL85000. (CONF-950923–4: 5. international conference on facility-safeguards interface, Jackson Hole, WY (United States), 24-30 Sep 1995). Order Number DE96000784. Source: OSTI; NTIS; INIS; GPO Dep.

Short communication. RADIOACTIVE MATERIALS/physical protection; NUCLEAR MATERIALS MANAGEMENT/international cooperation; SAFEGUARDS; SECURITY; URANIUM; PLUTONIUM; USA; USSR; SANDIA NATIONAL LABORATORIES

29144 (SAND–95-2135C) **The PAMTRAK system and its operational issues.** Dahly, B. (Sandia National Labs., Albuquerque,

NM (United States)); Walters, G. Sandia National Labs., Albuquerque, NM (United States). [1995]. 4p. Sponsored by USDOE, Washington, DC (United States). DOE Contract AC04-94AL85000. (CONF-950923–5: 5. international conference on facility-safeguards interface, Jackson Hole, WY (United States), 24-30 Sep 1995). Order Number DE96000720. Source: OSTI; NTIS; INIS; GPO Dep.

A system has been developed by Sandia National Laboratories (SNL) as part of the joint laboratory project with Los Alamos National Laboratory and Argonne National Laboratory-West (ANL-W). The objective is to provide support for Safeguards and Security and Nuclear Materials Control and Accountability within the DOE complex. Since its original design PAMTRAK has been enhanced to include material monitoring, personnel monitoring, and video surveillance. Material monitoring is provided by the WATCH (Wireless Alarm Transmission of Container Handling) subsystem by performing continuous surveillance via constantly monitored Tamper Indicating Devices of all material not directly involved in the fuel manufacturing process. Personnel tracking uses radio frequency and infrared sensors to detect unauthorized access to restricted areas and to enforce constant monitoring of containers or other objects within a "region of interest" in a storage vault or other restricted area. Advantages of combining these sensor subsystems include reducing personnel radiation exposure by extending the time between required physical inventory intervals as well as adding robustness to existing security measures. PAMTRAK is being demonstrated as part of the integrated materials monitoring and accounting system in the Fuels and Manufacturing Facility (FMF) located at ANL-W. This paper will describe the technologies employed for installation of the system by SNL, as well as the operational issues involved in using the system at ANL-W.

29145 (SAND–95-2136C) **Implementation of safeguards and security for fissile materials disposition reactor alternative facilities.** Jaeger, C.D.; Duggan, R.A.; Tolk, K.M. Sandia National Labs., Albuquerque, NM (United States). [1995]. 10p. Sponsored by USDOE, Washington, DC (United States). DOE Contract AC04-94AL85000. (CONF-950923–7: 5. international conference on facility-safeguards interface, Jackson Hole, WY (United States), 24-30 Sep 1995). Order Number DE96000721. Source: OSTI; NTIS; INIS; GPO Dep.

A number of different disposition alternatives are being considered and include facilities which provide for long-ten-n and interim storage, convert and stabilize fissile materials for other disposition alternatives, immobilize fissile material in glass and/or ceramic material, fabricate fissile material into mixed oxide (MOX) fuel for reactors, use reactor based technologies to convert material into spent fuel, and dispose of fissile material using a number of geologic alternatives. Particular attention will be given to the reactor alternatives which include existing, partially completed, advanced or evolutionary LWRs and CANDU reactors. The various reactor alternatives are all very similar and include processing which converts Pu to a usable form for fuel fabrication, a MOX fuel fab facility located in either the US or in Europe, US LWRs or the CANDU reactors and ultimate disposal of spent fuel in a geologic repository. This paper focuses on how the objectives of reducing security risks and strengthening arms reduction and nonproliferation will be accomplished and the possible impacts of meeting these objectives on facility operations and design. Some of the areas in this paper include: (1) domestic and international safeguards requirements, (2) non-proliferation criteria and measures, (3) the threat, and (4) potential proliferation risks, the impacts on the facilities, and safeguards and security issues unique to the presence of Category 1 or strategic special nuclear material.

29146 (SAND–95-2145C) **Developing and testing technologies for future remote monitoring systems.** Johnson, C.S.; Dupree, S.A. Sandia National Labs., Albuquerque, NM (United States). [1995]. 11p. Sponsored by USDOE, Washington, DC (United States). DOE Contract AC04-94AL85000. (CONF-950923–6: 5. international conference on facility-safeguards interface, Jackson Hole, WY (United States), 24-30 Sep 1995). Order Number DE96000722. Source: OSTI; NTIS; INIS; GPO Dep.

Remote monitoring systems presently operating in facilities in a number of countries around the world are providing valuable information on the installation and operation of such systems. Results indicate they are performing reliably. While the technology for remote monitoring exists today, it may be some time before numerous constraints on implementation can be resolved. However, the constraints should not prevent the designing of systems that can be used for remote monitoring. Selection of the proper technology path for future development should include a flexible approach to front-end detection, data formats, data processing, and other areas. A brief description of two of the existing remote monitoring systems, and some general recommendations for future remote monitoring systems, will be presented.

29147 (UCRL-ID–121109) **Derivation of plutonium-239 materials disposition categories.** Brough, W.G. Lawrence Livermore National Lab., CA (United States). 27 Apr 1995. 22p. Sponsored by USDOE, Washington, DC (United States). DOE Contract W-7405-ENG-48. Order Number DE96000137. Source: OSTI; NTIS; INIS; GPO Dep.

At this time, the Office of Fissile Materials Disposition within the DOE, is assessing alternatives for the disposition of excess fissile materials. To facilitate the assessment, the Plutonium-Bearing Materials Feed Report for the DOE Fissile Materials Disposition Program Alternatives report was written. The development of the material categories and the derivation of the inventory quantities associated with those categories is documented in this report.

29148 (UCRL-JC–120848) **Role of Lawrence Livermore National Laboratory in the Laboratory to Laboratory Nuclear Materials Protection, Control and Accounting (MPC&A) Program.** Blasy, J.A.; Koncher, T.R.; Ruhter, W.D. Lawrence Livermore National Lab., CA (United States). 2 May 1995. 5p. Sponsored by USDOE, Washington, DC (United States). DOE Contract W-7405-ENG-48. (CONF-9505227–4: 17. ERSADA symposium on safeguards and nuclear material management, Aachen (Germany), 9-11 May 1995). Order Number DE95015096. Source: OSTI; NTIS; GPO Dep.

The Lawrence Livermore National Laboratory (LLNL) is participating in a US Department of Energy sponsored multi-laboratory cooperative effort with the Russian Federation nuclear institutes to reduce risks of nuclear weapons proliferation by strengthening systems of nuclear materials protection, control, and accounting in both countries. This program is called the Laboratory-to-Laboratory Nuclear Materials Protection, Control, and Accounting (MPC&A) Program and it is designed to complement other US-Russian MPC&A programs such as the government-to-govermment (NunnLugar) programs. LLNL's role in this program has been to collaborate with various Russian institutes in several areas. One of these is integrated safeguards and security planning and analysis, including the performing of vulnerability assessments. In the area of radiation measurements LLNL is cooperating with various institutes on gamma-ray measurement and analysis techniques for plutonium and uranium accounting. LLNL is also participating in physical security upgrades including entry control and portals.

29149 (UCRL-JC–121564) **U.S./Russian Laboratory-to-Laboratory MPC&A Program at the VNIITF Institute, Chelyabinsk-70.** Teryohin, V. (VNIITF, Chelyabinsk (Russian Federation)); Tzygankov, G.; Blasy, J. Lawrence Livermore National Lab., CA (United States). Jul 1995. 8p. Sponsored by USDOE, Washington, DC (United States). DOE Contract W-7405-ENG-48. (CONF-950787–82: 36. annual meeting of the Institute for Nuclear Materials Management, Palm Desert, CA (United States), 9-12 Jul 1995). Order Number DE96000351. Source: OSTI; NTIS; INIS; GPO Dep.

The All Russian Institute of Technical Physics (VNIITF) is one of the major sites in the nuclear weapons complex in Russia. The site contains a number of research facilities which use nuclear material as well as facilities active in disassembly and disposition of nuclear weapons. Chelyabinsk-70 (C-70) also has ties to the major nuclear materials production facilities in the Urals region of Russia. Under the U.S./Russian Laboratory -to- Laboratory cooperative program, enhanced safeguards systems are being implemented, initially at a reactor test area that contains two pulse reactors and a nuclear material storage facility. C-70 is developing an extensive computerized system that integrates the physical security alarm station with elements of the nuclear material control system. Under the Lab-to-Lab program, the existing systems will bi augmented with Russian

and US technologies. The integrated MPC&A system for the test facilities will be demonstrated to US and Russian audiences when completed and follow-on work at additional C-70 facilities will be identified. This paper will describe the on-going activities and describe the cooperative effort between the Lawrence Livermore, Los Alamos, Sandia, Oak Ridge, Pacific Northwest, and Brookhaven US Department of Energy National Laboratories in support of VNIITF.

29150 (WHC-SA–2831) **Project planning at the Hanford Site for International Atomic Energy Agency (IAEA) safeguards of excess fissile material.** Smith, B.W. (Pacific Northwest Lab., Richland, WA (United States)); McRae, L.P.; Walker, A.C. Westinghouse Hanford Co., Richland, WA (United States). Jun 1995. 7p. Sponsored by USDOE, Washington, DC (United States). DOE Contract AC06-87RL10930. (CONF-950787–59: 36. annual meeting of the Institute for Nuclear Materials Management, Palm Desert, CA (United States), 9-12 Jul 1995). Order Number DE95015737. Source: OSTI; NTIS; INIS; GPO Dep.

In his September 1993 address to the United Nations General Assembly, President Clinton proposed several initiatives to promote nuclear nonproliferation. One element is of these initiatives was that the United States offered to place excess fissile material under International Atomic Energy Agency @A) safeguards. Three Department of Energy (DOE) facilities were identified as part of a phased approach for initial implementation. This paper describes the planning process used to provide information to assist the DOE in making decisions for the initial offer, outlines tasks to be performed, and develops a budget request. The process consisted of: (1) Characterizing the Hanford Site from the perspective of IAEA safeguards; (2) identify key issues to be resolved; (3) developing budget estimates and schedules; (4) interfacing with other DOE components and the IAEA to clarify expected activities; and (5) initiating additional data collection and preparatory activities to reduce planning uncertainties.

29151 (WHC-SA–2834) **Comparison of NDA and DA measurement techniques for excess plutonium powders at the Hanford Site: Statistical design and heterogeneity testing.** Welsh, T.L. (Westinghouse Hanford Co., Richland, WA (United States)); McRae, L.P.; Delegard, C.H.; Liebetrau, A.M.; Johnson, W.C.; Theis, W.; Lemaire, R.J.; Xiao, J. Westinghouse Hanford Co., Richland, WA (United States). Jun 1995. 7p. Sponsored by USDOE, Washington, DC (United States). DOE Contract AC06-87RL10930. (CONF-950787–26: 36. annual meeting of the Institute for Nuclear Materials Management, Palm Desert, CA (United States), 9-12 Jul 1995). Order Number DE95015738. Source: OSTI; NTIS; INIS; GPO Dep.

Quantitative physical measurements are a n component of the International Atomic Energy Agency (IAEA) nuclear material m&guards verification regime. In December 1994, LA.FA safeguards were initiated on an inventory of excess plutonium powder items at the Plutonium Finishing Plant, Vault 3, on the US Department of Energy's Hanford Site. The material originl from the US nuclear weapons complex. The diversity of the chemical form and the heterogenous physical form of this inventory were anticipated to challenge the precision and accuracy of quantitative destructive analytical techniques. A sampling design was used to estimate the degree of heterogeneity of the plutonium content of a variety of inventory items. Plutonium concentration, the item net weight, and the ^{240}Pu content were among the variables considered in the design. Samples were obtained from randomly selected location within each item. Each sample was divided into aliquots and analyzed chemically. Operator measurements by calorimetry and IAEA measurements by coincident neutron nondestructive analysis also were performed for the initial physical inventory verification materials and similar items not yet under IAEA safeguards. The heterogeneity testing has confirmed that part of the material is indeed significantly heterogeneous; this means that precautionary measures must be taken to obtain representative samples for destructive analysis. In addition, the sampling variability due to material heterogeneity was found to be comparable with, or greater than, the variability of the operator's calorimetric measurements.

29152 (WHC-SA–2902) **A survey of United States Department of Energy access control.** Duncan, M. (Westinghouse Hanford Co., Richland, WA (United States)); Toms, D. Westinghouse Hanford Co., Richland, WA (United States). Jun 1995. 10p. Sponsored by USDOE, Washington, DC (United States). DOE Contract AC06-87RL10930. (CONF-950787–74: 36. annual meeting of the Institute for Nuclear Materials Management, Palm Desert, CA (United States), 9-12 Jul 1995). Order Number DE95016339. Source: OSTI; NTIS; GPO Dep.

The US Department of Energy (DOE) protects a wide range of assets through the use of access controls. Basic requirements are defined in departmental policy; however, the procedures and equipment used for implementation by sites and contractors varies. The DOE has conducted a survey of processes and equipment used to conduct access control at their facilities. This review was conducted via visits to DOE sites and interviews with staff members in the areas of physical security, automated systems, and badging and visitor control. Data have been collected and documented in a structured format for retrieval and analysis. This paper discusses some of the survey results. The data collected will assist the DOE in their policy development activities in the area of access control. These activities include important decisions concerning the national implementation of the DOE Common Badge and complex-wide visitor access control systems.

0560 Legislation and Regulations

Refer also to citation(s) 29490, 29872, 29873

29153 (DOE/EH–231-011/0592) **Waste management and the land disposal restriction storage prohibition.** USDOE Assistant Secretary for Environment, Safety, and Health, Washington, DC (United States). Office of Environmental Guidance. May 1992. 4p. Sponsored by USDOE, Washington, DC (United States). Order Number DE96001035. Source: OSTI; NTIS; INIS; GPO Dep.

RCRA Sect. 3004(j) prohibits storage of wastes that have been prohibited from land disposal, unless that storage is for the purpose of accumulating sufficient quantities of hazardous wastes to facilitate proper recovery, treatment, or disposal. This requirement was incorporated as part of the Land Disposal Restriction (LDR) regulations. Under the LDR storage prohibition, facilities may only store restricted wastes in containers and tanks. As stated in the Third LDR rule, storage of prohibited waste is only allowed in non-land based storage units since land-based storage is a form of disposal. The EPA has recognized that generators and storers of radioactive mixed waste (RMW) may find it impossible to comply with storage prohibition in cases where no available treatment capacity exists. Additionally, under the current regulatory interpretation, there is no provision that would allow for storage of wastes for which treatment capacity and capability are not available, even where capacity is legitimately being developed. Under the LDR program, restricted wastes that are disposed of, or placed into storage before an LDR effective date, are not subject to the LDR requirements. However, if such wastes are removed from a storage or disposal site after the effective date, such wastes would be subject to LDR requirements. The purpose of this information brief is to clarify what waste management practices constitute removal from storage.

29154 (INIS-mf–14556, pp. 7) **Nuclear Techniques in Medicine and Human Health.** Nofal, M.M. (Former Director, Division of Human Health, IAEA Professor Emeritus, Nuclear Medicine, Alexandria Univ., (Egypt)). Atomic Energy Establishment, Cairo (Egypt). Jun 1994. 84p. (CONF-9406263–: National seminar on nuclear energy in everyday life, Cairo (Egypt), 23-29 Jun 1994). In *National seminar on nuclear energy in everyday life: lectures.* Order Number DE96601738. Source: OSTI; NTIS (US Sales Only); INIS.

I would like to thank the organizers of this seminar on Nuclear Energy in everyday life for inviting me to address this distinguished audience about Nuclear Techniques in Medicine and Human Health. May be it is time for me to say some plain, simple words of wisdom which I acquired during my exile in the wilderness of Vienna where I had the opportunity to step aside from the hurry and worry of the day to day clinical practice of nuclear medicine and reflect on wider international issues. I have few questions which I would like to ask and try to find an answer to them. The first question that arises is whether nuclear techniques in medicine are

necessary in a developing country? Are nuclear medicine and radiotherapy a luxury for a general hospital in such countries? Is a nuclear reactor as much of a status symbol in a newly emerging nation as a steel mill or new international jet airline. In many cases, nuclear medicine for example has been conceived to ease the conscience and justify to some extent the investment in nuclear energy. To conceive the role of nuclear medicine in the health care has been easy, but to deliver it to local hospitals is most often a case of obstructed labour.

07 ISOTOPE AND RADIATION SOURCE TECHNOLOGY

0701 Physical Isotope Separation

Refer also to citation(s) 30241, 30606, 30614

29155 (INIS-mf–14592) **Tritium extraction from neutron-irradiated lithium aluminate.** Garcia H, F. Universidad Nacional Autonoma de Mexico, Mexico City (Mexico). 1995. 60p. (In Spanish). Order Number DE96602677. Source: OSTI; NTIS (US Sales Only); INIS.

Lithium aluminate is being strongly considered as a breeder material because of its thermophysical, chemical and mechanical stability at high temperatures and its favorable irradiation behavior. Furthermore, it is compatible with other blanket and structural materials. In this work, the effects of calcination temperature during preparation, extraction temperature and sweep gas composition were observed. Lithium aluminate prepared by four different methods, was neutron irradiated for 30 minutes at a flux of 10^{12} -10^{13} n/cm^2 s in the TRIGA Mark III reactor at Salazar, Mexico; and the tritium extraction rate was measured. Calcination temperature do not affect the tritium extraction rate. However, using high calcination temperature, gamma lithium aluminate was formed. The tritium extraction at 600 Centigrade degrees was lower than at 800 Centigrade degrees and the tritium amount extracted by distillation of the solid sample was higher. The sweep gas composition showed that tritium extraction was less with Ar plus 0.5 % H_2 that with Ar plus 0.1 % H_2. This result was contrary to expected, where the tritium extraction rate could be higher when hydrogen is added to the sweep gas. Probably this effect could be attributed to the gas purity. (Author).

29156 (MLM–23) **Monsanto Chemical Company, Unit 3 progress report, January 16–31, 1948.** Monsanto Chemical Co., Dayton, OH (United States). [1948]. 6p. Sponsored by USDOE, Washington, DC (United States). DOE Contract AC24-88DP43495. Order Number DE96001488. Source: OSTI; NTIS; GPO Dep.

Calorimetry: Twenty-six samples have been assayed for other groups; unit IV calorimeters agree with Unit III calorimeters to 0.5 per cent; the calorimeters of type 30 are practically finished. Experiments on the significance of speed and sensitivity continue and are discussed at length; and a 2.68 Curie sample for tests of heat distribution error has been procured. Mathematical Analysis: The half-life determination from the third set of Unit III counting room data was completed; the formula developed by the Calorimetry Group for the speed of calorimeters was evaluated; and text books and articles treating the theory of probability and its application, especially counting techniques, have been studied.

29157 (MLM–61) **Process research progress report, February 16–29, 1948.** Hamilton, P. Monsanto Chemical Co., Dayton, OH (United States). [1948]. 7p. Sponsored by USDOE, Washington, DC (United States). DOE Contract AC24-88DP43495. Order Number DE96001489. Source: OSTI; NTIS; GPO Dep.

Treatment of Hot Liquid Waste: Three runs, D-73, D-74, and D-75, were made in the model clariflocculator during this period. In D-73 and D-74 a mixture of hydrolysis supernatant and water was used as the original solution and in D-75 a hydrolysis supernatant, bismuth free activity and water mixture was used as the starting solution. D-73 gave acceptable results, but D-74 and D-75 gave results that were not too satisfactory. It is believed that contamination in the laboratory has effected the results. Recovery of Bismuth: Experiments were resumed on the electrolytic extraction of bismuth from a hydrochloric acid solution of bismuth chloride. Plating at elevated temperature with the elimination of calcium chloride resulted in a lower average deposition rate of 2.07 g./amp.–hr. than was obtained at room temperature in the presence of calcium chloride with a deposition rate of 2.30 g./amp.–hr. Another comparison was made between cathodes prepared in a wood mold and a "Herculite" mold. Unlike the results obtained in run E-15 in which the cathode prepared in the "Herculite" mold gave a greater average deposition rate, the same deposition rate of 2.00 g/amp.–hr. was obtained with both cathodes. The formation of crystals was more prevalent in the case of the cathode cast in the wood mold. In run E-24 a cathode with a rough surface-was prepared by lining the side of the mold with carborundum cloth. The deposit consisted of nodules over the entire surface and very little treeing at the edges. Treatment of Hot Solid Burnable Waste: The final enclosure of the incinerator with asbestos and transite is in progress. Preliminary consideration is being given to the steam expansion method of cleaning air as a means of removing the activity which would be carried over in the flu gases.

29158 (MLM–66) **Physics progress report, March 1–31, 1948.** Davis, R. Jr. Monsanto Chemical Co., Dayton, OH (United States). [1948]. 12p. Sponsored by USDOE, Washington, DC (United States). DOE Contract AC24-88DP43495. Order Number DE96001492. Source: OSTI; NTIS; GPO Dep.

The quarts gauge apparatus for measuring the vapor pressure of postum was completed. The first sample of postum oxidized in the course of preparation, while in a presumably sealed and evacuated quartz tube. an error of 0.4 per cent appears to be present in the vacuum weighing of postum. a diffusion pump is being installed to reduce the pressure, in the hope of minimizing the radiometer effect. Repetition of the effusion experiment with a rebuilt crucible yielded four points below those reported last time by a factor of ten in pressure. A leak appeared in the crucible, requiring construction of a new one. X-ray patterns were again obtained for the Q metal sample, #33, and oxide sample, #42. Work on the calibration of the two new powder cameras is proceeding satisfactorily. Two samples of cadmium were made for the purpose of developing a technique for producing single crystals of metals. A sample of tellurium nitrate yielded the same pattern as that reported in the literature. Data on the characteristics of a newly designed tub type moderator as compared with the Hanson cylinder are presented. Some notes on the calculation of probable error show the minimum error to depend upon the ratio of source strength to background.

29159 (MLM–72) **Process research progress report, March 1–31, 1948.** Hamilton, P. Monsanto Chemical Co., Dayton, OH (United States). [1948]. 21p. Sponsored by USDOE, Washington, DC (United States). DOE Contract AC24-88DP43495. Order Number DE96001493. Source: OSTI; NTIS; GPO Dep.

Treatment of Hot Liquid Waste: According to the Eimco Corporation, the filter on order in to be shipped the first week of April. Sketches have been prepared giving the general location of the Eimco filter and equipment to be used in testing the unit. No suitable gauge is available for the tanks to be used in the W. D. Building for storing corrosive solutions. A gauge, to be fabricated from polystyrene, has been designed. Treatment of Hot Solid Burnable Waste: Construction of the model incinerator has been completed. A general discussion of the problem and design of the incinerator is included in the Detailed Report. Some time has been spent gathering together material for the final report covering the experimental work on the disposal of "hot" liquid wastes. Recovery of Bismuth: Further work an the electrolytic extraction of bismuth has indicated that the formation of the bismuth deposited on the cathode in neither influenced by etching the electrode with nitric acid nor by varying the cooling rate of the cast electrode. A near theoretical yield was obtained (2.58 g./amp./hr.) by enclosing the cathode in a screen, of glass cloth. The diaphragm, in all probability, reduces the amount of chlorine near the surface of the cathode with a resulting diminution of the reaction between chlorine and the bismuth metal.

29160 (MLM–85) **Physics group process report, April 1–30, 1948.** Knauss, H.P. Monsanto Chemical Co., Dayton, OH (United States). [1948]. 18p. Sponsored by USDOE, Washington, DC

(United States). DOE Contract AC24-88DP43495. Order Number DE96001496. Source: OSTI; NTIS; GPO Dep.

The high rate neutron scaler has been removed from service for repair. Consequent study has led to the discovery of a double counting effect. The vacuum system of the vacuum balance is being redesigned and rebuilt so as to obtain a higher vacuum. The vapor pressure of postum was measured with a quartz sickle gauge between 0.3 and 90 mm. of mercury pressure at temperatures between 430° and 745°C. The least square representation of the data is the following: Log p = $_T\frac{5377.8}{}$ + 7.2345 where p is the pressure in mm. of mercury and T is the absolute temperature. From this least square equation the extrapolated boiling point is 962.1°1°C. and the latent heat of vaporization is 24,597 calories per mole. A single crystal study of potassium chloride is being made since it is the crystal which is most nearly like a simple cubic lattice. The Geiger counter X-ray spectrometer belonging to Unit I was set up and a recorder attached so that certain patterns could be obtained more quickly. Continuation of the effusion experiment showed that data obtained were violently inconsistent. The experimental work is being dropped. At the end of the Physics Group Progress Report section, a brief report is included which describes the exhibits designed and constructed for "The Miami Valley Atomic Energy Show" at Miamisburg, Ohio, April 29, 30, and May I, 1948 by members of the Physics Group.

29161 (MLM–173) **Electrodeposition research progress report, August 1–31, 1948.** Mound Lab., Miamisburg, OH (United States). [1948]. 12p. Sponsored by USDOE, Washington, DC (United States). DOE Contract AC04-76DP00053. Order Number DE96001428. Source: OSTI; NTIS; GPO Dep.

Studies to test the conversion of production solutions to postum (polonium 210) solutions of hydrofluoric acid involving compressed teflon are documented. Several experiments to assess the effect on production plating yields are described including varying time between rinses, current density, and use of detergents. Varying the time between rinses showed no correlation with the neutron counts on the finished gauzes.

29162 (MLM–174) **Electronics progress report, August 1–31, 1948.** Heyd, J.W. Mound Lab., Miamisburg, OH (United States). [1948]. 11p. Sponsored by USDOE, Washington, DC (United States). DOE Contract AC04-76DP00053. Order Number DE96001429. Source: OSTI; NTIS; GPO Dep.

Various studies centering on problems and their solutions encountered in electroplating production at Mound Laboratory. Some studies described include construction of the Scaler-Multiplier EL-229, operation of a methane-flow proportional counter, life-time decreases of production half-cells, and use of vibrating reed electrometer.

29163 (MLM–204) **Production Division progress report, September 1–30, 1948.** Burbage, J.J. Mound Lab., Miamisburg, OH (United States). [1948]. 4p. Sponsored by USDOE, Washington, DC (United States). DOE Contract AC24-88DP43495. Order Number DE96001448. Source: OSTI; NTIS; GPO Dep.

Experiments are progressing on the development and testing of a special Logac-L contamination shield. Further investigations are being made on the possible effect of time on the mass purity of polonium deposited from product solutions.

29164 (MLM–220) **Neutron source progress report, October 1–31, 1948.** Richmond, J.L. Mound Lab., Miamisburg, OH (United States). [1948]. 12p. Sponsored by USDOE, Washington, DC (United States). DOE Contract AC24-88DP43495. Order Number DE96001508. Source: OSTI; NTIS; GPO Dep.

This document details progress in neutron source development by Mound Laboratory during the month of October 1948.

29165 (MLM–236) **Electronics progress report.** Heyd, J.W. Mound, Miamisburg, OH (United States). 30 Nov 1948. 20p. Sponsored by USDOE, Washington, DC (United States). DOE Contract AC24-88DP43495. Order Number DE96001515. Source: OSTI; NTIS; GPO Dep.

The work to determine the feasibility of a pratical solution counter for alphas has been continued through this month. It has developed that the electronic technique using an Amperex mica-window GM tube (1.4 mg./cm^2 mica) is reliable, and it now appears that the problem is mainly one of solution-mounting technique. Two four-input gamma mixers and three two-input B-wall mixers have been given a final check and assembled in cabinets with their associated scalers. These scalars, Instrument Development Laboratory Model 161-S, were modified for use with either type mixer and may also be used for straight GM counting. One Instrument Development Laboratory Model 161-S, scale of 256 gamma counter has been given performance tests before being placed in operation at Mound Laboratory. Tests are being run on the parallel plate alpha counter Model K-262.

29166 (MLM–251) **Electronics progress report, December 1–31, 1948.** Heyd, J.W.; Ohmart, P.E. Mound Lab., Miamisburg, OH (United States). [1948]. 35p. Sponsored by USDOE, Washington, DC (United States). DOE Contract AC24-88DP43495. Order Number DE96001521. Source: OSTI; NTIS; GPO Dep.

Equipment and supplies are being packed for moving to Mound Laboratory. Work was started on the development of a cathode-follower circuit to match a B-wall tube to its connecting cable. The final report and maintenance manual for the scaler-multiplier are almost finished. The 10 millivolt Speedomax recorder used by Group 3 in the study of electrodeposition potentials has been replaced with a 150 millivolt Speedomax, utilizing two recording points for simultaneous recording of radioactive deposition and the plating cell current. Three two-input B-wall mixers, three scaler-multipliers, one four-input Geiger-Mueller mixer and five Thyratron heater controls were delivered to Group 24. One high-current plating control, EL-173, was delivered to Group 17. The following instruments are complete: portable pulse generator, EL-261, the instruction book and photographs will be submitted for approval at an early date. Portable regulation checker, EL-258. Preliminary tests have been made, instructions are being written and drawings are being made.

0702 Radiation Sources

Refer also to citation(s) 30379, 30401

29167 (ANSTO/E–700) **Coincidence-counting corrections for accidental coincidences, set dead time and intrinsic dead time.** Wyllie, H.A. Australian Nuclear Science and Technology Organisation, Lucas Heights, NSW (Australia). Dec 1991. 145p. Order Number DE96602680. Source: OSTI; NTIS; INIS.

An equation is derived for calculating the radioactivity of a source from the results of coincidence counting, taking into account dead-time losses and accidental coincidences. The corrections allow for the extension of the set dead time in the β channel by the intrinsic dead time. Experimental verification shows improvement over a previous equation. 9 refs., 1 tab., 53 figs.

29168 (ANSTO/E–701) **Correction for intrinsic and set dead-time losses in radioactivity counting.** Wyllie, H.A. Australian Nuclear Science and Technology Organisation, Lucas Heights, NSW (Australia). Dec 1992. 55p. Order Number DE96602681. Source: OSTI; NTIS; INIS.

Equations are derived for the determination of the intrinsic dead time of the components which precede the paralysis unit in a counting system for measuring radioactivity. The determination depends on the extension of the set dead time by the intrinsic dead time. Improved formulae are given for the dead-time correction of the count rate of a radioactive source in a single-channel system. A variable in the formulae is the intrinsic dead time which is determined concurrently with the counting of the source. The only extra equipment required in a conventional system is a scaler. 5 refs., 2 tabs., 21 figs.

29169 (ARL/TR–111) **Asian/Australasian region intercalibration and intercomparison programme for radon, thoron and daughters. Asian/Australasian region radon intercomparison, September 1987 - September 1988.** Peggie, J.R.; Gan, Tianghong; Solomon, S.B. Australian Radiation Lab., Melbourne, VIC (Australia). May 1993. 50p. Order Number DE96602682. Source: OSTI; NTIS; INIS.

The International Intercalibration and Intercomparison Programme for radon, thoron and daughters monitoring equipment,

abbreviated IIIP, was a programme organized jointly by the Nuclear Energy Agency of the Organization for Economic Cooperation and Development and the Radiation Protection Research Programme of the Commission of European Communities. The broad purpose of the IIIP was to determine if the diverse calibration procedures used in different countries were equivalent. The general approach was to select four regional reference laboratories and entrust then with the details of project definition and execution. The Australian Radiation Laboratory (ARL) was selected to co-ordinate IIIP activities between OECD member countries in the Pacific region. As the regional programme precluded the participation of non-OECD member countries in the Western Pacific Region, an intercomparison series for radon was initiated by ARL in 1987 between twenty eight laboratories from nine countries in the Asian/Australasian region. The methodology and protocols for grab sampler, solid state nuclear track detectors (SSNTD) and charcoal measurements are described in this report. Generally the results showed reasonable agreement between the majority of laboratories for grab sampler measurements consistent with previous intercomparison. However there were large systematic differences in the results of the passive monitors for some laboratories. For all samplers, it was found that the overall random uncertainty or replication error, which included random uncertainties associated with the counting and calibration, were the main sources of variability between individual measurements of participants and the ARL reference value, with calibration uncertainties predominating. 23 tabs.

29170 (JAERI-Research–95-047) **Sludge pasteurization and upgrading by radiation. Bilateral research cooperation between OAEP and JAERI.** Japan Atomic Energy Research Inst., Tokyo (Japan). Jul 1995. 181p. Order Number DE96701398. Source: OSTI; NTIS; INIS.

The research cooperation between office of Atomic Energy for Peace, Thailand (OAEP) and Japan Atomic Energy Research Institute (JAERI) on 'Sludge Pasteurization and Upgrading by Radiation' was carried out for 4 years starting from March 1990. This cooperation was performed through information exchange meetings (Steering Committee Meeting), held in Takasaki and Bangkok, and experiments and discussions by scientist exchange, Many useful results were obtained on radiation inactivation effect of pathogen and parasites, upgrading of irradiated sludges to fertilizer, animal feeds and biological pesticides. This report includes the main results of the research cooperation reported at the First to Fifth Steering Committee Meetings as the progress reports. (author).

29171 (LA-UR–95-3035) **X-ray source production in foil implosion machines.** Rich, M.; Matuska, W. Los Alamos National Lab., NM (United States). [1995]. 10p. Sponsored by USDOE, Washington, DC (United States). DOE Contract W-7405-ENG-36. (CONF-950750–42: 10. Institute of Electrical and Electronics Engineers (IEEE) pulsed power conference, Albuquerque, NM (United States), 10-13 Jul 1995). Order Number DE96000067. Source: OSTI; NTIS; INIS; GPO Dep.

A number of two-dimensional radiation-magneto-hydrodynamic foil implosion calculations are discussed which explore ways of producing warm x-ray sources (~60 eV) in a reproducible manner and which would permit close-in access to the source. The discussions include the effects of contoured electrodes on the foil implosion and source output, and of tapering the average mass distribution along the length of the foil. Primarily, source evaluation by jet formation and stagnation against a dense stopping block is treated.

29172 (LBL–36645) **Multicusp sources for ion beam lithography applications.** Leung, K.N.; Herz, P.; Kunkel, W.B.; Lee, Y.; Perkins, L.; Pickard, D.; Sarstedt, M.; Weber, M.; Williams, M.D. Lawrence Berkeley Lab., CA (United States). May 1995. 13p. Sponsored by USDOE, Washington, DC (United States). DOE Contract AC03-76SF00098. (CONF-9505122–8: International conference on ion beam analysis, Tempe, AZ (United States), 22-26 May 1995). Order Number DE96001124. Source: OSTI; NTIS; GPO Dep.

Application of the multicusp source for Ion Projection Lithography is described. It is shown that the longitudinal energy spread of the positive ions at the extraction aperture can be reduced by employing a magnetic filter. The advantages of using volume-produced H^- ions for ion beam lithography is also discussed.

29173 (LBL–37556) **Femto-second pulses of synchrotron radiation.** Zholents, A.A. (Lawrence Berkeley Lab., CA (United States)); Zolotorev, M.S. Lawrence Berkeley Lab., CA (United States); Stanford Univ., CA (United States). Jul 1995. 6p. Sponsored by USDOE, Washington, DC (United States). DOE Contract AC03-76SF00098 ; AC03-76SF00515. Order Number DE96001014. Source: OSTI; NTIS; INIS; GPO Dep.

A method capable of producing femto-second pulses of synchrotron radiation is proposed. It is based on the interaction of femto-second light pulses with electrons in a storage ring. The application of the method to the generation of ultra-short x-ray pulses at the Advance Light Source of Lawrence Berkeley National Laboratory has been considered. The same method can also be used for extraction of electrons from a storage ring in ultra-short series of microbunches spaced by the periodicity of light wavelength.

29174 (MLM–11) **Monsanto Chemical Company, Unit 3 progress report, January 1–15, 1948.** Monsanto Chemical Co., Dayton, OH (United States). [1948]. 4p. Sponsored by USDOE, Washington, DC (United States). DOE Contract AC24-88DP43495. Order Number DE96001486. Source: OSTI; NTIS; GPO Dep.

This document details progress on neutron source development by Monsanto Chemical Company during the time period of January 1 through January 15, 1948.

29175 (MLM–92) **Neutron source progress report, April 1–30, 1948.** Richmond, J. Monsanto Chemical Co., Dayton, OH (United States). [1948]. 9p. Sponsored by USDOE, Washington, DC (United States). DOE Contract AC24-88DP43495. Order Number DE96001498. Source: OSTI; NTIS; GPO Dep.

This document details progress in neutron source development by Monsanto Chemical Company during the month of April 1948.

29176 (MLM–124) **Production division progress report, May 1–31, 1948.** Burbage, J.J. Mound Lab., Miamisburg, OH (United States). [1948]. 12p. Sponsored by USDOE, Washington, DC (United States). DOE Contract AC04-76DP00053. Order Number DE96001421. Source: OSTI; NTIS; GPO Dep.

A long term study on the possible effect of time on the microassay purity of postum product solutions is reported. It was determined that within the time periods studied (up to 102 days) time has no discernible effect on the mass purity of the postum electrodeposited from product solutions.

29177 (MLM–178) **Neutron source progress report, August 1–31, 1948.** Richmond, J. Mound Lab., Miamisburg, OH (United States). [1948]. 8p. Sponsored by USDOE, Washington, DC (United States). DOE Contract AC04-76DP00053. Order Number DE96001431. Source: OSTI; NTIS; GPO Dep.

The preparation and shipping of several postum (polonium 210) neutron sources are described. Sources include those composed of postum- lithium, postum-beryllium, and postum-sodium.

29178 (MLM–200) **Neutron source progress report, September 1–30, 1948.** Richmond, J.L. Mound Lab., Miamisburg, OH (United States). [1948]. 8p. Sponsored by USDOE, Washington, DC (United States). DOE Contract AC24-88DP43495. Order Number DE96001445. Source: OSTI; NTIS; GPO Dep.

This document details progress in neutron source development by Mound Laboratory during the month of September 1948.

29179 (MLM–242) **Neutron source progress report, November 1–30, 1948.** Richmond, J.L. Mound Lab., Miamisburg, OH (United States). [1948]. 8p. Sponsored by USDOE, Washington, DC (United States). DOE Contract AC24-88DP43495. Order Number DE96001517. Source: OSTI; NTIS; GPO Dep.

This document details progress in the development of neutron sources by Mound Laboratory for the month of November 1948.

29180 (UM-P–94/117) **Neutron capture on nitrogen as a means of detecting explosives.** Thompson, M.N.; Rassool, R.P. Melbourne Univ., Parkville, VIC (Australia). School of Physics. [1995]. 9p. (CONF-9410373–: In-service training seminar of the International Association of Bomb Technicians and Investigators, Canberra (Australia), 13 Oct 1994). Order Number DE96602684. Source: OSTI; NTIS; INIS.

A research prototype was developed on the basis of neutron capture on nitrogen and is demonstrated to be able to detect parcel and letter bombs. Is the gamma radiation that is detected as an indication of the presence of nitrogen, and the probable presence of nitrogen-containing explosive. The conceptual design of the explosive detector and some experimental results are briefly presented. figs., ills.

29181 (Y/DW–1367) **Evaluation of photoneutron production at high energy LINACS.** Bell, Z.W. Oak Ridge Y-12 Plant, TN (United States). 24 Apr 1995. 26p. Sponsored by USDOE, Washington, DC (United States). DOE Contract AC05-84OS21400. Order Number DE96000399. Source: OSTI; NTIS; INIS; GPO Dep.

This report describes an estimate of neutron production at a 9 MeV LINAC, and the potential for photoactivation of materials present at the LINAC facility. It was found that only isotopes of U, W, Ta, and Pb had daughters whose activities might be measurable. The LINAC was found to be capable of producing in the neighborhood of 10^{10} neutrons/second from these heavy metals, and that subsequent neutron activation might be more of a concern. Monte Carlo simulation of neutron transport and capture in the concrete and steel found in the LINAC vault indicates that ^{55}Fe may be produced in measurable quantities.

0703 Isotopic Power Supplies

29182 (DOE/SF/18852–T56) **GPHS-RTGs in support of the Cassini Mission. Semi-annual technical progress report, April 3, 1995–October 1, 1995.** Martin Marietta Astro Space, King of Prussia, PA (United States). 24 Oct 1995. 90p. Sponsored by USDOE, Washington, DC (United States). DOE Contract AC03-91SF18852. Order Number DE96001142. Source: OSTI; NTIS; INIS; GPO Dep.

This document is the April-October 1995 Progress Report on the Cassini RTG Program. Nine tasks are summarized; (1) Spacecraft integration and liason, (2) Engineering support, (3) Safety, (4) Unicouple fabrication, (5) ETG fabrication, assembly, and test, (6) Ground support equipment, (7) RTG shipping and launch support, (8) Design, reviews, and mission applications, and (9) Project management, QA, contract changes, and material acquisitions.

0705 Health and Safety

29183 (MLM–172) **Shielding studies at Mound Laboratory.** Bradley, J.E.; Richmond, J.L. Monsanto Chemical Co., Dayton, OH (United States). 24 Aug 1948. 10p. Sponsored by USDOE, Washington, DC (United States). DOE Contract AC04-76DP00053. Order Number DE96001427. Source: OSTI; NTIS; GPO Dep.

Neutron shielding is done to protect workers from excessive radiation and to keep a low neutron background for research in neutron counting. To meet health standards the total neutron flux allowable is 150 n/cm/sec per eight hours, or 50 n/cm/sec per twenty-four hours. Literature values for the absorption coefficients of paraffin and water are considered, and some experimental data is presented which approximately confirm them. A description of barriers at Mound Laboratory is given. Plans for future work on slowing-down of fast nautrons and capture of slow neutrons are included.

0706 Environmental Aspects

29184 (ANSTO/E–714) **General aspects of meteorology and wind flow patterns at the National Medical Cyclotron site, Camperdown, NSW, Australia.** Clark, G.H.; Bartsch, F.J.K. Australian Nuclear Science and Technology Organisation, Lucas Heights, NSW (Australia). Jun 1994. 26p. Order Number DE96602637. Source: OSTI; NTIS; INIS.

As part of an assessment into the consequences of a potential accident at the National Medical Cyclotron, Camperdown, NSW., Australia, two meteorological stations were installed to monitor the winds, temperatures and atmospheric dispersion conditions. The data will be used to assess environmental impacts of the Cyclotron's operation. In spite of the relatively poor performance of the stations, the wind data indicated significant effects of local buildings and the general urban surface roughness features. The prevailing winds during the study were from the north-north-west at night and south-south-west or north-east sea breezes during the day. Atmospheric stability/dispersion categories were typical of an urban heat island location. 11 refs., 10 tabs, 6 figs.

29185 (INIS-mf–14556, pp. 1-9) **Nuclear Energy and The Public. Lecture 1.** Kyd, D.R. (International Atomic Energy Agency, Vienna (Austria)). Atomic Energy Establishment, Cairo (Egypt). Jun 1994. 84p. (CONF-9406263–: National seminar on nuclear energy in everyday life, Cairo (Egypt), 23-29 Jun 1994). In *National seminar on nuclear energy in everyday life: lectures.* Order Number DE96601738. Source: OSTI; NTIS (US Sales Only); INIS.

I know that for many people - including scientists and teachers - the words 'atomic' or 'nuclear' provoke unease or even fear. They think first and foremost of bombs or of Chernobyl. It is absolutely right to be aware of the risks of some uses of the atom, because they do exist. But equally we should not overlook, for instance, that ionizing radiation is a principal way of combating cancer. Also, over 16% of the world's electricity supply comes from nuclear power - about the same as what we get from hydro power. Used for peaceful purposes, and prudently, nuclear energy applications have, I submit, tremendous benefits to offer mankind, not only in the industrialized world but also in the developing nations.

0707 Regulation and Licensing

Refer also to citation(s) 29491, 29865

29186 (NUREG/CR–6324) **Quality assurance for gamma knives.** Jones, E.D. (Lawrence Livermore National Lab., CA (United States)); Banks, W.W.; Fischer, L.E. Nuclear Regulatory Commission, Washington, DC (United States). Div. of Industrial and Medical Nuclear Safety; Lawrence Livermore National Lab., CA (United States). Sep 1995. 133p. Sponsored by Nuclear Regulatory Commission, Washington, DC (United States). DOE Contract W-7405-ENG-48. (UCRL-ID–120056). Source: OSTI; NTIS; INIS; GPO.

This report describes and summarizes the results of a quality assurance (QA) study of the Gamma Knife, a nuclear medical device used for the gamma irradiation of intracranial lesions. Focus was on the physical aspects of QA and did not address issues that are essentially medical, such as patient selection or prescription of dose. A risk-based QA assessment approach was used. Sample programs for quality control and assurance are included. The use of the Gamma Knife was found to conform to existing standards and guidelines concerning radiation safety and quality control of external beam therapies (shielding, safety reviews, radiation surveys, interlock systems, exposure monitoring, good medical physics practices, etc.) and to be compliant with NRC teletherapy regulations. There are, however, current practices for the Gamma Knife not covered by existing, formalized regulations, standards, or guidelines. These practices have been adopted by Gamma Knife users and continue to be developed with further experience. Some of these have appeared in publications or presentations and are slowly finding their way into recommendations of professional organizations.

08 HYDROGEN

0801 Production

Refer also to citation(s) 29260, 29809, 29967

29187 (ETDE/CH-mf–95787322, pp. 3-5) **Catalytic dehydrogenation of methylcyclohexane in fixed bed reactors with an ex situ palladium (Pd)-silver (Ag) membrane.** Cuellar, A. (Paul Scherrer Inst. (PSI), Villigen (Switzerland)); Scheidegger, T.; Wyss, C.; Newson, E. Paul Scherrer Inst. (PSI), Villigen (Switzerland). 1995. In *Paul Scherrer Institut annual report 1994. Annex V: PSI general energy technology newsletter 1994.* 123p. Source: OSTI; NTIS.

An ex situ Pd-AG (23 wt%) foil membrane with 50 μm wall thickness has been used to selectively remove hydrogen (H_2) from the

reaction products in the catalytic dehydrogenation of methylcyclohexane (MCH) to toluene (TOL). Upon removal of H_2 the equilibrium conversion of methylcyclohexane was exceeded by 3-5%. The membrane has been successfully tested for stability during approximately 200 h of continuous dehydrogenation. After regeneration by air oxidation followed by reduction, the membrane regained its full permeability. (author) 3 figs., 8 refs.

29188 (ETDE/CH-mf–95787322, pp. 30-32) **A novel 2-step water-splitting thermochemical cycle for solar energy conversion.** Tamaura, Y. (Tokyo Inst. of Technology, Research Center for Carbon Recycling and Utilization, Tokyo (Japan)); Steinfeld, A.; Kuhn, P.; Ehrensberger, K. Paul Scherrer Inst. (PSI), Villigen (Switzerland). 1995. In *Paul Scherrer Institut annual report 1994. Annex V: PSI general energy technology newsletter 1994.* 123p. Source: OSTI; NTIS.

A novel, two-step, water-splitting cycle is presented which, in contrast to previously proposed cycles that require upper operating temperatures above 2300 K, can be conducted at a much moderate temperature. In the first, endothermic step, $Ni_{0.5}Mn_{0.5}Fe_2O_4$ is thermally activated above 1073 K to form an oxygen-deficient ferrite. In the second step activated ferrite is reacted with water below 1073 K to form hydrogen; the ferrite products is recycled to the first step. H_2 and O_2 are derived in different steps, eliminating the need for high-temperature gas separation. Both reactions have been experimentally demonstrated using concentrated solar radiation as the energy source for the activation. (author) 3 figs., 1 tab., 13 refs.

29189 (ETDE/CH-mf–95787322, pp. 33-34) **Solar-processed zinc as clean energy carrier.** Steinfeld, A. (Paul Scherrer Inst. (PSI), Villigen (Switzerland)); Kuhn, P. Paul Scherrer Inst. (PSI), Villigen (Switzerland). 1995. In *Paul Scherrer Institut annual report 1994. Annex V: PSI general energy technology newsletter 1994.* 123p. Source: OSTI; NTIS.

Zinc is an attractive candidate for storage and transport of solar energy. It may be used to deliver either high-temperature heat via combustion, or electricity via zinc-air batteries, or hydrogen via water-splitting reaction. In this paper we thermodynamically examine the simultaneous solar processing of zinc and synthesis gas by combined thermal reduction of zinc oxide with methane reforming. (author) 2 figs., 7 refs.

0802 Storage, Transport, and Handling

Refer also to citation(s) 30188

29190 (DOE/CE/50343–3) **Multi-fuel reformers for fuel cells used in transportation: Assessment of hydrogen storage technologies. Phase 2: Final report.** Little (Arthur D.), Inc., Cambridge, MA (United States). May 1995. 174p. Sponsored by USDOE, Washington, DC (United States). DOE Contract AC02-92CE50343. Order Number DE96000681. Source: OSTI; NTIS; GPO Dep.

During Phase 1 of this program, the authors evaluated all known hydrogen storage technologies (including those that are now practiced and those that are development) in the context of fuel cell vehicles. They determined that among the development technologies, carbon sorbents could most benefit from closer scrutiny. During Phase 2 of this program, they tested ten different carbon sorbents at various practical temperatures and pressures, and developed the concept of the usable Capacity Ratio, which is the ratio of the mass of hydrogen that can be released from a carbon-filled tank to the mass of hydrogen that can be released from an empty tank. The authors also commissioned the design, fabrication, and NGV2 (Natural Gas Vehicle) testing of an aluminum-lined, carbon-composite, full-wrapped pressure vessel to store hydrogen at 78 K and 3,000 psi. They constructed a facility to pressure cycle the tank at 78 K and to temperature cycle the tank at 3,000 psi, tested one such tank, and submitted it for a burst test. Finally, they devised a means by which cryogenic compressed hydrogen gas tanks can be filled and discharged using standard hardware–that is, without using filters, valves, or pressure regulators that must operate at both low temperature and high pressure. This report describes test methods and test results of carbon sorbents and the design of tanks for cold storage. 7 refs., 91 figs., 10 tabs.

29191 (LA-UR–95-2462) **A comparison of hydrogen vehicle storage options using the EPA urban driving schedule.** Daugherty, M.A.; Prenger, F.C.; Daney, D.E.; Hill, D.D.; Edeskuty, F.J. Los Alamos National Lab., NM (United States). [1995]. 8p. Sponsored by USDOE, Washington, DC (United States). DOE Contract W-7405-ENG-36. (CONF-950722–8: Cryogenic engineering conference and international cryogenic materials conference, Columbus, OH (United States), 17-21 Jul 1995). Order Number DE95016913. Source: OSTI; NTIS; GPO Dep.

The three standard options for the storage of hydrogen fuel on passenger vehicles are compressed gas, metal hydride and cryogenic liquid storage. The weight of the hydrogen storage system affects the performance of the vehicle. We examine vehicle performance as a function of hydrogen storage system type and capacity. Three vehicles are modeled, a metro commuter, a mid size sedan and a full size van. All vehicles are powered by a fuel cell and an electric drive train. The impact of auxiliary power requirements for air conditioning is also examined. In making these comparisons it is necessary to assume a driving cycle. We use the United States Environmental Protection Agency (EPA) urban dynamometer driving schedule in all simulations to represent typical urban driving conditions.

29192 (NEDO-IT–9306) **Survey on high-level application of new-functional metal hydride (MH) to industrial equipment.** New Energy and Industrial Technology Development Organization, Tokyo (Japan). Mar 1994. 164p. (In Japanese). Order Number DE96704380. Source: OSTI; NTIS; Available from New Energy and Industrial Technology Development Organization, Sunshine 60, 30F 1-1, 3-chome, Higashi-Ikebukuro, Toshima-ku, Tokyo, Japan.

A survey of research and development overseas and in Japan was conducted on application of metal hydride (MH) to new-functional industrial equipment such as actuators which make good use of properties of MH. An MH actuator manufactured based on a new movement principle is useful as welfare equipment in terms of its big power generated, light-weight and quiet motion. MH can raise and lower heavy matters by release and absorption of hydrogen gas. In the example where the MH actuator is used for raising and lowering the seat portion of the wheelchair, a total weight of the rise/fall portion of the wheelchair seat was found to be approximately 5 kg including that of the battery. As to welfare equipment and tools which are expectedly commercialized by using MH actuators, considered are an aid lift for taking a bath, a western-style toilet seat with a function of helping stand-up, a bedsore preventing bed, a device aiding motions of fingers/elbows, etc. Besides the welfare equipment, considered are force display for presenting force information, a small-size muscular reinforcement training device, ocean robot needing high power and low speed, etc. 72 refs., 110 figs., 28 tabs.

0804 Economic, Industrial, and Business Aspects

Refer also to citation(s) 29192

29193 (DOE/CE/34027–T14) **Support services for the Office of Energy efficiency and renewable energy. Quarterly progress report, July 1, 1995–September 30, 1995.** Sen (R.K.) and Associates, Inc., Bethesda, MD (United States). [1995]. 5p. Sponsored by USDOE, Washington, DC (United States). DOE Contract AC01-94CE34027. Order Number DE96001046. Source: OSTI; NTIS; GPO Dep.

R.K. Sen & Associates, Inc., under Contract No. DE-AC01-94CE34027, provides technical and economic analysis support services to the Advanced Utility Concepts Division (AUCD) of DOE. Energetics, Inc. is a subcontractor to R.K. Sen & Associates, Inc. The work performed under this contract is mainly for the DOE Hydrogen R&D Program, although a limited amount of activities are also undertaken for the DOE Battery Energy Storage Program.

09 BIOMASS FUELS

0907 Resources

Refer also to citation(s) 29206

29194 (CONF-9508104–5) **Large-scale biomass plantings in Minnesota: Scale-up and demonstration projects in perspective.** Kroll, T. (Minnesota Univ., St. Paul, MN (United States). Forestry Div.); Downing, M. Oak Ridge National Lab., TN (United States). [1995]. 10p. Sponsored by USDOE, Washington, DC (United States). DOE Contract AC05-84OR21400. From 2. meeting on biomass of the Americas; Portland, OR (United States); 21-24 Aug 1995. Order Number DE95017439. Source: OSTI; NTIS; GPO Dep.

Scale-up projects are an important step toward demonstration and commercialization of woody biomass because simply planting extensive acreage of hybrid poplar will not develop markets. Project objectives are to document the cost to plant and establish, and effort needed to monitor and maintain woody biomass on agricultural land. Conversion technologies and alternative end-uses are examined in a larger framework in order to afford researchers and industrial partners information necessary to develop supply and demand on a local or regional scale. Likely to be determined are risk factors of crop failure and differences between establishment of research plots and agricultural scale field work. Production economics are only one consideration in understanding demonstration and scale-up. Others are environmental, marketing, industrial, and agricultural in nature. Markets for energy crops are only beginning to develop. Although information collected as a result of planting up to 5000 acres of hybrid poplar in central Minnesota will not necessarily be transferable to other areas of the country, a national perspective will come from development of regional markets for woody and herbaceous crops. Several feedstocks, with alternative markets in different regions will eventually comprise the entire picture of biofuels feedstock market development. Current projects offer opportunities to learn about the complexity and requirements that will move biomass from research and development to actual market development. These markets may include energy and other end-uses such as fiber.

29195 (NREL/CP–200-8098, pp. 30-39) **Biomass resources for electric generation in the Pacific Northwest.** Kerstetter, J.D. (Washington State Energy Office, Olympia, WA (United States)). National Renewable Energy Lab., Golden, CO (United States). [1995]. (CONF-9508104–: 2. meeting on biomass of the Americas, Portland, OR (United States), 21-24 Aug 1995). In *Second biomass conference of the Americas: Energy, environment, agriculture, and industry. Proceedings.* 1741p. Order Number DE95009230. Source: OSTI.

Biomass fuels offer a unique energy resource for electric generation in the Pacific Northwest. They are produced as a coproduct from our needs for food, fiber, and structural materials. Many of the fuels are considered as waste products from the major manufacturing process and are available for the cost of transportation. About 1,055 PJ (1,000 TBtu) of biomass residues are generated each year in the Pacific Northwest. Traditional sources of biomass fuels include forest residues, wood manufacturing residues, agricultural field residues, and municipal solid waste (MSW). Woody residues have a long history of being used for electric generation, especially from cogeneration facilities located at pulp mills. MSW facilities were built in the 1980s but interest has declined with the availability of large regional landfills. Forest residues and agricultural field residues are not used in the region but are used in increasing amounts for electric generation in California. Other biomass resources include spent pulping liquors, biogas from animal manure and landfills, and residues from fiber plantations. A major question addressed in this paper is the future availability and cost of biomass fuels. Biomass fuels offer several environmental advantages. With the exception of MSW they are inherently clean burning. Their low sulfur and nitrogen content permits burning without the need for acid gas scrubbers. Their carbon dioxide emissions on an energy basis are comparable to coal but there is one important difference. The biological growth of biomass fuels consumes carbon dioxide as part of the photosynthetic process and thus their net contribution to global warming is zero. The utility industry has increased its interest in biomass fuels because of the carbon dioxide advantages.

29196 (NREL/CP–200-8098, pp. 55-64) **Biomass energy opportunities on former sugarcane plantations in Hawaii.** Phillips, V.D. (Univ. of Hawaii, Honolulu, HI (United States)); Tvedten, A.E.; Lu, W. National Renewable Energy Lab., Golden, CO (United States). [1995]. DOE Contract AC05-84OR21400. (CONF-9508104–: 2. meeting on biomass of the Americas, Portland, OR (United States), 21-24 Aug 1995). In *Second biomass conference of the Americas: Energy, environment, agriculture, and industry. Proceedings.* 1741p. Order Number DE95009230. Source: OSTI.

Electricity produced from burning sugarcane bagasse has provided as much as 10 percent of Hawaii's electricity supply in the past. As sugarcane production has ceased on the islands of Oahu and Hawaii and diminished on Maui and Kauai, the role of biomass energy will be reduced unless economically viable alternatives can be identified. An empirical biomass yield and cost system model linked to a geographical information system has been developed at the University of Hawaii. This short-rotation forestry decision support system was used to estimate dedicated biomass feedstock supplies and delivered costs of tropical hardwoods for ethanol, methanol, and electricity production. Output from the system model was incorporated in a linear programming optimization model to identify the mix of tree plantation practices, wood processing technologies, and end-products that results in the highest economic return on investment under given market situations. An application of these decision-support tools is presented for hypothetical integrated forest product systems established at two former sugarcane plantations in Hawaii. Results indicate that the optimal profit opportunity exists for the production of medium density fibreboard and plywood, with annual net return estimates of approximately $3.5 million at the Hamakua plantation on the island of Hawaii and $2.2 million at the Waialua plantation on Oahu. Sensitivity analyses of the effects of different milling capacities, end-product market prices, increased plantation areas, and forced saw milling were performed. Potential economic credits for carbon sequestration and wastewater effluent management were estimated. While biofuels are not identified as an economical viable component, energy coproducts may help reduce market risk via product diversification in such forestry ventures.

29197 (NREL/CP–200-8098, pp. 65-76) **Technologies for delivering forest biomass: Challenges and implications.** McNeel, J.F. (USDA Forest Service, Seattle, WA (United States)). National Renewable Energy Lab., Golden, CO (United States). [1995]. (CONF-9508104–: 2. meeting on biomass of the Americas, Portland, OR (United States), 21-24 Aug 1995). In *Second biomass conference of the Americas: Energy, environment, agriculture, and industry. Proceedings.* 1741p. Order Number DE95009230. Source: OSTI.

Technological developments in biomass harvesting peaked in the early mid-seventies. Harvest operations in natural stands often included the removal of biomass material with conventional products like pulpwood and sawlogs. Since that time, forest management philosophies have changed dramatically, emphasizing partial harvests and thinnings over clearcut harvests. This change has, in turn, affected the type of equipment used for harvesting. The emphasis on leaving slash and debris on site, rather than remove it as a potential biomass product, has further affected the ability to effectively harvest biomass material from our forests. Newly developed logging systems, called cut-to-length systems, were introduced from Scandinavia in the mid-eighties and produced a minor revolution in our forests. The design of these systems emphasized stand and site protection over high production and low costs. Biomass production has diminished as a priority of harvesting system design to a point where the cost of producing a ton of biomass may well exceed its market value. Harvest systems studies summarized in this report suggest that these newer systems do protect the forest environment, but at a cost to biomass and conventional production. Overall, the cost to produce conventional sawlogs and pulpwood may have increased by 40 to 50 percent using these newer systems. Biomass, typically produced at a smaller profit margin than conventional material, may have increased in cost even more than 50 percent. Even conventional systems cost 20 to 30 percent more

to operate in the partial harvests commonly prescribed on our forests. In contrast, the value of biomass has not increased at the same rate as conventional products. Competing energy sources have affected the demand for energy wood and chips that were marketed only as fuel in the past, are now being sought for engineered wood products at a higher price. Current trends do not favor biomass production in many areas of North America.

29198 (NREL/CP–200-8098, pp. 77-87) **Resource potential of wood-based wastes in the United States.** McKeever, D.B. (USDA Forest Service, Madison, WI (United States)). National Renewable Energy Lab., Golden, CO (United States). [1995]. (CONF-9508104–: 2. meeting on biomass of the Americas, Portland, OR (United States), 21-24 Aug 1995). In *Second biomass conference of the Americas: Energy, environment, agriculture, and industry. Proceedings.* 1741p. Order Number DE95009230. Source: OSTI.

Large amounts of waste are generated in the United States annually. Although much of this material is indeed waste, an increasing share is becoming a valuable resource. Wood is usually thought of as a renewable, not a recyclable, resource. However, solid residues from primary timber processing facilities have been recycled into usable products for decades. Wooden pallets are recycled into new pallets or other wood products at an increasing rate, and wood waste from construction and demolition sites is becoming an important commodity. Wood from urban waste collection may too proven to be a valuable resource. The first step in developing waste wood into a viable resource is to quantify the amounts of waste wood available by source and type of material. There are three major sources of wood waste in the United States-municipal solid waste (MSW), new construction and demolition waste, and wood residues from primary timber manufacturing facilities. Included in MSW are pallets and yard waste. In this report, total amounts of waste generated, amounts of wood waste generated by type, and amounts of wood waste potentially available for recycling are quantified for each source of waste. Estimates are based on published waste generation volumes and rates, measures of economic activity, and trends in virgin wood use in specific markets. The report also identifies possible uses for each source of wood waste and includes recommendations for better utilizing this resource.

29199 (NREL/CP–200-8098, pp. 140-150) **Resource mapping and analysis of UK farm livestock manures: Assessing the opportunities for biomass-to-energy technologies.** Dagnall, S.P. (ETSU, Oxfordshire (United Kingdom)). National Renewable Energy Lab., Golden, CO (United States). [1995]. (CONF-9508104–: 2. meeting on biomass of the Americas, Portland, OR (United States), 21-24 Aug 1995). In *Second biomass conference of the Americas: Energy, environment, agriculture, and industry. Proceedings.* 1741p. Order Number DE95009230. Source: OSTI.

Livestock farms produce wastes with a high potential for pollution. Alternative, environmentally acceptable disposal routes might lie in biomass-to-energy schemes, generating revenue from the energy produced and fertiliser as a by-product; these are currently being developed, or assessed, for the UK under DTI/MAFF collaborative programmes; two options are being considered-direct combustion (12-14MW_e) and centralised anaerobic digestion (0.1-1MW_e CHP). One of the barriers to initiating such schemes is establishing where feedstocks are located in order that they may be exploited in a cost effective manner. Resource mapping and analysis using a Geographical Information System has been used to establish the opportunities for England and Wales. This work was carried out in two parts: produce spatially distributed resource data, of agro-industrial wastes and farm livestock manures, expressed in tonnes dry solids, from which energy production figures were derived; and develop algorithms to establish how much of this resource could be feasibly exploited. By comparing these resource data with other appropriate information (e.g., road networks, environmentally sensitive areas, grid interconnections), the optimum location and size of potential biomass-to-energy plants were determined. Whilst interest in such schemes is anticipated to grow further over the next few years, their future will be heavily dependent upon the level of concern for wider environmental issues.

29200 (NREL/CP–200-8098, pp. 151-157) **Urban wood waste resource assessment, the state of Indiana.** Haase, S.G. (NEOS Corporation, Lakewood, CO (United States)); Quinn, M.W.; Whittier, J.P. National Renewable Energy Lab., Golden, CO (United States). [1995]. (CONF-9508104–: 2. meeting on biomass of the Americas, Portland, OR (United States), 21-24 Aug 1995). In *Second biomass conference of the Americas: Energy, environment, agriculture, and industry. Proceedings.* 1741p. Order Number DE95009230. Source: OSTI.

The purpose of this study is to quantify the wood waste resources produced on an annual basis within the state of Indiana. The project was developed in five steps. These steps included: (1) identifying the population of current wood waste generators in 11 metropolitan areas; (2) determining the annual volume of urban wood waste in the following categories: construction and demolition, tree trimmings and clearings, wood pallets, and primary and secondary wood processors waste; (3) identifying the current disposition of urban wood wastes and residues; (4) estimating the energy potential of urban wood wastes and residues; and, (5) identification of energy markets that may be appropriate for urban wood wastes. The total estimated wood residue generated on an annual basis within these regions is 1.13 million bone dry tons per year with approximately 743,047 BDT/year available for use in the energy market, an equivalency of 398,000 tons of bituminous coal. Greater amounts are generated than are available because much of the "waste" is actually consumed for a variety of products including mulch, bedding, compost, and fuel. Based on information collected through this study, approximately 127,912 BDT/year of wood residues are presently consumed for energy purposes, either as space or process heat. This accounts for 1.9 trillion Btu/year, which is roughly equivalent to 68,000 tons of coal. If the wood residues produced and presently consumed for fuel by rural primary processors are added to the metropolitan figures, then there are approximately 3.3 trillion Btu of wood waste consumed for fuel purposes on an annual basis in Indiana.

29201 (NREL/CP–200-8098, pp. 158-167) **Urban wood waste in Michigan: Supply and policy issues.** Snyder, J.D. (Public Policy Associates, Lansing, MI (United States)). National Renewable Energy Lab., Golden, CO (United States). [1995]. (CONF-9508104–: 2. meeting on biomass of the Americas, Portland, OR (United States), 21-24 Aug 1995). In *Second biomass conference of the Americas: Energy, environment, agriculture, and industry. Proceedings.* 1741p. Order Number DE95009230. Source: OSTI.

This study provides the most comprehensive and detailed nonproprietary assessment and characterization of urban wood waste (UWW) to date for Michigan and the U.S. Nine components of the UWW stream were quantified and analyzed by surveying 44 UWW haulers and processors and 19 urban wood foresters in the Detroit, Grand Rapids, and Lansing markets. The nine UWW components consist of (1) used pallets, (2) wood scraps, (3) construction debris, (4) demolition debris, (5) tree trimming residue, (6) land clearing wood waste, (7) plywood/particleboard waste, (8) used railroad ties, and (9) "other" wood waste. UWW is defined as wood residue generated by municipal, industrial, commercial, construction, and demolition sources, and includes pallets/dunnage, wood scraps, construction and demolition debris, railroad ties, tree trimmings, land clearing, plywood/particleboard, and other UWW component streams. Our final estimate of 593,395 tonnes of annually generated UWW compares with 781,630 tonnes of residue generated by Michigan's secondary wood manufacturing industry. Our study estimates that 90 MW of electric generating capacity can be produced from the UWW supply in our study area. Total electric power capacity is about 20,000 MW in the state. The UWW market was found to be highly dependent on used pallet generation (46% of total UWW). Current fuel demand by Michigan's wood burning power facilities is 1,530,360 TPY and will increase to 1,936,800 TPY as a major new facility comes on-line. Unless regulatory standards for "contaminated" wood supplies are relaxed, supply shortages may occur. Other significant end-markets for UWW compete for UWW supplies which may drive prices up. UWW markets and prices are extremely volatile, and they are extremely sensitive to various regulatory and market factors that are not always carefully considered nor understood.

29202 (NREL/CP–200-8098, pp. 188-196) **Perspectives for energy processing of waste biomass in Bulgaria.** Aladjadjian, A.G. (Agricultural Univ., Plovdiv (Bulgaria)). National Renewable Energy Lab., Golden, CO (United States). [1995]. (CONF-9508104–: 2. meeting on biomass of the Americas, Portland, OR (United States), 21-24 Aug 1995). In *Second biomass conference of the Americas: Energy, environment, agriculture, and industry. Proceedings.* 1741p. Order Number DE95009230. Source: OSTI.

Biomass is a renewable energy resource and is especially important now because fossil energy sources are almost exhausted. Bulgaria is not rich in fossil fuels. Its total industrial reserves of coal are equal to 825 Mt OE. The total primary energy supply in Bulgaria in 1992 was 302 PJ, or 9.6 Mt OE. A significant part of primary energy needs is imported, so the national economy is dependent on world fuel prices. Waste biomass-to-energy systems could be a good alternative. Approximately 60% of Bulgaria is arable land and about 30% is forest. The calculations of the energy equivalent of waste biomass alone in 1992 show that the total energy that could have been obtained by biomass processing is about 90.5 PJ or 2 Mt OE. This is about 22% of the total energy consumption in Bulgaria in 1992.

29203 (NREL/CP–200-8098, pp. 1636-1647) **Forest management issues affecting biomass resources: A forest service perspective.** Tran, H.C. (USDA Forest Service, Washington, DC (United States)); MacCleery, D. National Renewable Energy Lab., Golden, CO (United States). [1995]. (CONF-9508104–: 2. meeting on biomass of the Americas, Portland, OR (United States), 21-24 Aug 1995). In *Second biomass conference of the Americas: Energy, environment, agriculture, and industry. Proceedings.* 1741p. Order Number DE95009230. Source: OSTI.

Several conditions are affecting strategies to manage forest ecosystems for long-term sustainability: (1) forest ecosystem health problems with insects and disease, (2) increasing buildup of fuels and danger of catastrophic fires, and (3) loss of lives, property, and resources associated with fire in the wildland/urban interface. These conditions have significant implications for the availability of biomass for fuels and fiber products and provide added incentives to manage biomass to achieve sustainable conditions. The authors will discuss the above problems which can be viewed as opportunities to meet both resource management and economic objectives through management of excess biomass. Inventory of biomass accumulation shows that the rate of growth of biomass far exceeds the rate of removal thus exacerbating the problems. Particular attention will be paid to the role of fire as an ecosystem process. The impact of decades of fire exclusion leading to increasing areas of dense fuels, loss in biological diversity, and greater susceptibility of many forests to insects, disease, and catastrophic fires will be examined. There is also a great need to focus on fuels management with respect to areas associated with the high-risk wildland/urban interface areas. These management related issues will be strong driving forces for the use of biomass markets as a tool to manage forest lands.

29204 (NREL/CP–200-8098, pp. 1680-1688) **Agriculture: A source of raw materials for industrial purposes the French strategy.** Mauguin, P. (Agence de l'Environnement et de la Maitrise de l'Energie, Paris (France)); Gaouyer, J.P.; Labrousse, S. National Renewable Energy Lab., Golden, CO (United States). [1995]. (CONF-9508104–: 2. meeting on biomass of the Americas, Portland, OR (United States), 21-24 Aug 1995). In *Second biomass conference of the Americas: Energy, environment, agriculture, and industry. Proceedings.* 1741p. Order Number DE95009230. Source: OSTI.

Creating new value-added products from agricultural and forestry biomass can present opportunities for diversifying industry, preserving agricultural activities and reinvigorating exploitation of forests. Stimulating new markets for agriculture and forestry products is strategically important for France, in order to cushion the effects of the reform of the European Common Policy (CAP), while maintaining the commitments assessed at the Rio Coference. The promotion of new markets should constitute a major vector for rural development, by marking use of agricultural lands no longer needed for food crops due to the glut of foodstuffs on the market. In the next few years, energy uses of biomass should help hold down greenhouse gas emissions, by regulating and storing CO_2. For each of these markets, whether for energy uses (solid, liquid or gaseous fuels) or for other applications, the first priority is to match prices and specifications of the fossil fuels that are to be deplaced, with minimum impact on the environment. To match these goals, the French government has launched a new research group, Agriculture for Chemicals and Energy (AGRICE). AGRICE has been set up for a renewable five years period. Its members are: Agriculture, Industry, Research and Environment departments; the Institut National de la Recherche Agronomique (INRA), the Institut Francais due Petrole (IFP), the French Agency for Environment and Energy (Ademe); Wheat producers, Beet growers, and oil seed producers; and Rhone Poulenc (chemicals), TOTAL (oil company). In 1995, AGRICE will have a 40 Millions FFrancs from public funds, supplemented by 25 Millions FFrancs from business and trade groups.

29205 (NREL/CP–200-8098, pp. 1722-1731) **Potential for electricity generation from biomass residues in Cuba.** Lora, E.S. (Universidad de Oriente, Santiago (Cuba)). National Renewable Energy Lab., Golden, CO (United States). [1995]. (CONF-9508104–: 2. meeting on biomass of the Americas, Portland, OR (United States), 21-24 Aug 1995). In *Second biomass conference of the Americas: Energy, environment, agriculture, and industry. Proceedings.* 1741p. Order Number DE95009230. Source: OSTI.

The purpose of this paper is the study of the availability of major biomass residues in Cuba and the analysis of the electricity generation potential by using different technologies. An analysis of the changes in the country's energy balance from 1988 up to date is presented, as well as a table with the availability study results and the energy equivalent for the following biomass residues: sugar cane bagasse and trash, rice and coffee husk, corn an cassava stalks and firewood. A total equivalent of 4.42 10^6 tons/year of fuel-oil was obtained. Possible scenarios for the electricity production increase in the sugar industry are presented too. The analysis is carried out for a high stream parameter CEST and two BIG/GT system configurations. Limitations are introduced about the minimal milling capacity of the sugar mills for each technology. The calculated "real" electricity generation potential for BIG/GT systems, based on GE LM5000 CC gas turbines, an actual cane harvest of 58.0 10^6 tons/year, half the available trash utilization and an specific steam consumption of 210 kg/tc, was 18601,0 GWh/year. Finally different alternatives are presented for low-scale electricity generation based on the other available agricultural residues.

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Refer also to citation(s) 29194, 29196, 29314, 29322, 29327, 29354

29206 (NREL/CP–200-8098, pp. 1-10) **Demonstration and commercial production of biomass for energy.** Wright, L.L. (Oak Ridge National Lab., TN (United States)). National Renewable Energy Lab., Golden, CO (United States). [1995]. DOE Contract AC05-84OR21400. (CONF-9508104–: 2. meeting on biomass of the Americas, Portland, OR (United States), 21-24 Aug 1995). In *Second biomass conference of the Americas: Energy, environment, agriculture, and industry. Proceedings.* 1741p. Order Number DE95009230. Source: OSTI.

Five years ago, environmentally benign biomass crop technologies were only beginning to be commercialized and they were being used for products other than fuels. Twenty organizations could be identified in the U.S. and Canada that had plantings of at least 20 ha in size or greater of short-rotation woody crops and of those 12 were established by forest products companies. All commercial activity was with woody crops since herbaceous crops were still be evaluated by the DOE program. In the intervening 5 years, significant progress has been made on identifying the potential of a herbaceous crop, switchgrass, as an environmentally desirable and highly productive potential energy feedstock. The recent harvest and use of hybrid polars for pulp and paper production have clearly demonstrated the value of genetically superior hybrid poplar clones. Significant progress has been made in developing sophisticated techniques which will enable even more improvement of hybrid poplars for a variety of locations. Interest is

emerging from the forest products industry in all parts of the country regarding the potential of short-rotation woody crops. While the primary use of commercially planted woody crops continues to be for pulp and paper, energy is a co-product in nearly all situations. Additionally, some serious consideration is being given to the economics of using woody and/or herbaceous crops for a variety of energy production processes. Feasibility studies have or are being conducted by 10 or more groups around the country and several serious proposals for biomass energy demonstrations have recently been received by the Department of Energy in response to a solicitation for cost-shared demonstration projects. There continues to be numerous constraints to the commercialization of biomass crops for energy without federal assistance or policy modifications.

29207 (NREL/CP–200-8098, pp. 11-20) **Using an integrated forest thinning/biomass power strategy to save northwest forests.** Carlson, W.H. (Wheelabrator Environmental Systems, Inc., Anderson, CA (United States)); Duffy, J.L. National Renewable Energy Lab., Golden, CO (United States). [1995]. (CONF-9508104–: 2. meeting on biomass of the Americas, Portland, OR (United States), 21-24 Aug 1995). In *Second biomass conference of the Americas: Energy, environment, agriculture, and industry. Proceedings.* 1741p. Order Number DE95009230. Source: OSTI.

Wheelabrator Environmental Systems (WESI) has proposed to the United States Forest Service (USFS) and Bonneville Power Power Administration (BPA) to demonstrate an integrated forest thinning/biomass power generation system on USFS lands in Northeastern Oregon. The project, lasting 3 years, and thinning approximately 10,000 acres, would demonstrate the dramatic improvements in forest health and fire potential reduction that can be achieved by these techniques at no cost to the USFS. These techniques, developed over the last 10 years primarily on private lands in Northern California, involve marking the forest to remain following treatment, with the contractor carefully removing the excess material from the site. To maximize value from the techniques, that region should possess sawmills, pulp and paper facilities, and biomass power plants. For this project, WESi will lease and refurbish an existing 6MW power plant owned by Blue Mountain Forest Products at Long Creek, Oregon. All residual fuel from the thinning will fuel this facility, with what saw timber and pulp chips results being sold into existing regional markets. The project will demonstrate that, even on a small scale, the thinning can be accomplished at no cost to the USFS. The results will be shown to be highly desirable from a public policy and public acceptance standpoint. The operation and results will be studied by the Blue Mountain Natural Resources Institute to show that the resource has been improved in a variety of ways and degraded in none. The project will show the need for expanded contracting authority by the USFS to accomplish such work on a much wider basis. The ultimate goal will be to demonstrate that the thinning technologies demonstrated should become the forest management practice of choice on overstocked, dead and dying USFS/BLM lands in the Pacific Northwest.

29208 (NREL/CP–200-8098, pp. 21-29) **Large-scale biomass plantings in Minnesota: Scale-up and demonstrating projects in perspective.** Kroll, T. (Minnesota Department of Natural Resources, St. Paul, MN (United States)); Downing, M. National Renewable Energy Lab., Golden, CO (United States). [1995]. DOE Contract AC05-84OR21400. (CONF-9508104–: 2. meeting on biomass of the Americas, Portland, OR (United States), 21-24 Aug 1995). In *Second biomass conference of the Americas: Energy, environment, agriculture, and industry. Proceedings.* 1741p. Order Number DE95009230. Source: OSTI.

Scale-up projects are an important step toward demonstration and commercialization of woody biomass because simply planting extensive acreage of hybrid poplar will not develop markets. Project objectives are to document the cost to plant and establish, and effort needed to monitor and maintain woody biomass on agricultural land. Conversion technologies and alternative end-uses are examined in a larger framework in order to afford researchers and industrial partners information necessary to develop supply and demand on a local or regional scale. Likely to be determined are risk factors of crop failure and differences between establishment of research plots and agricultural scale field work. Production economics are only one consideration in understanding demonstration and scale-up. Others are environmental, marketing, industrial, and agricultural in nature. Markets for energy crops are only beginning to develop. Although information collected as a result of planting up to 5000 acres of hybrid poplar in central Minnesota will not necessarily be transferable to other areas of the country, a national perspective will come from development of regional markets for woody and herbaceous crops. Several feedstocks, with alternative markets in different regions will eventually comprise the entire picture of biofuels feedstock market development. Current projects offer opportunities to learn about the complexity and requirements that will move biomass from research and development to actual market development. These markets may include energy and other end-uses such as fiber.

29209 (NREL/CP–200-8098, pp. 40-48) **Short rotation willow coppice in Wales: High production under adverse environmental conditions.** Slater, F.M. (Univ. of Wales, Cardiff (United Kingdom)); Hodson, R.W.; Randerson, P.F. National Renewable Energy Lab., Golden, CO (United States). [1995]. (CONF-9508104–: 2. meeting on biomass of the Americas, Portland, OR (United States), 21-24 Aug 1995). In *Second biomass conference of the Americas: Energy, environment, agriculture, and industry. Proceedings.* 1741p. Order Number DE95009230. Source: OSTI.

The production of short rotation willow coppice in central Wales was once regarded as a vain hope rather than a distinct possibility. Research at the University of Wales, Cardiff, Field Station at Llysdinam in mid-Wales over the last four years has proven that it is possible to produce a commercially viable crop on very poor upland soils and at an altitude of almost 300m provided that lime and inorganic fertilizers are added. Because of the national need to find new routes for the disposal of sewage sludge, its addition to short rotation coppice serves the dual purpose of disposal and nutrient addition. Over the first two years of the sludging experiment, it was found that the addition of 300 m^3ha^{-1} of digested sewage sludge significantly increased crop weight, at least in the first year. Unfortunately, the crop yields did not reach those obtained using inorganic fertilizers at the same site but it is suggested that a repeated application regime might improve overall crop yield.

29210 (NREL/CP–200-8098, pp. 49-54) **Determination of the potential market size and opportunities for biomass-to-electricity projects in China.** Perlack, R.D. (Oak Ridge National Lab., TN (United States)). National Renewable Energy Lab., Golden, CO (United States). [1995]. DOE Contract AC05-84OR21400. (CONF-9508104–: 2. meeting on biomass of the Americas, Portland, OR (United States), 21-24 Aug 1995). In *Second biomass conference of the Americas: Energy, environment, agriculture, and industry. Proceedings.* 1741p. Order Number DE95009230. Source: OSTI.

Efforts are currently underway to assess the market potential and prospects for the U.S. private sector in biomass energy development in Yunnan Province. Among the specific objectives of the study are to: estimate the likely market size and competitiveness of biomass energy; assess the viability of U.S. private sector ventures; assess non-economic factors (e.g., resource, environmental, social, political, institutional) that could affect the viability of biomass energy; and recommend appropriate actions to help stimulate biomass initiatives. Feasibility studies show that biomass projects in Yunnan Province are financially and technically viable. Biomass can be grown and converted to electricity at costs lower than other alternatives. These projects if implemented can ease power shortages and help to sustain the region's economic growth. The external environmental benefits of integrated biomass projects are also potentially significant. This paper summarizes a two-step screening and rank-ordering process that is being used to identify the best candidate projects for possible U.S. private sector investment. The process uses a set of initial screens to eliminate projects that are not technically feasible to develop. The remaining projects are then rank-ordered using a multicriteria technique.

29211 (NREL/CP–200-8098, pp. 130-139) **Harvesting cotton stalks for use as a biomass feedstock.** Coates, W. (Univ. of Arizona, Tucson, AZ (United States)). National Renewable Energy Lab., Golden, CO (United States). [1995]. (CONF-9508104–: 2. meeting on biomass of the Americas, Portland, OR (United States), 21-24 Aug 1995). In *Second biomass conference of the Americas:*

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In Arizona, cotton residue left in the field following harvest must be buried, to prevent it from serving as an overwintering site for insects such as the pink bollworm. Most field operations to accomplish this are energy-intensive and often degrade soil structure, thereby increasing erosion and adding to particulate matter in the air. A system to harvest and transport this residue, instead of burying it, would be an economic benefit to cotton producers, and protect the environment as well. A project underway at the University of Arizona since 1991 has led to the development of two systems for harvesting cotton plant residue. Stalks are first pulled with an implement developed for the purpose, and then baled using a large round baler, or chopped with a forage harvester and placed in a cotton module builder. Density of the packages has varied, with the modules ranging from 168 to 252 kg/m^3 (10 to 15 lb/ft^3), and round bales from 93 to 168 kg/m^3 (6 to 9 lb/ft^3). Energy required per ton of material harvested has averaged 9.2 kWh/t (12.1 hp-hr/ton) for the baling system, and 8.6 kWh/t (11.4 hp-hr/ton) for chopping. Economics of the two systems are currently being evaluated. End use of the biomass, yield per acre, and distance from the field to the end use facility, will determine which system is optimal for a specific farmer.

29212 (NREL/CP–200-8098, pp. 207-215) **Is there a need for site productivity functions for short-rotation woody crop plantings.** Downing, M. (Oak Ridge National Lab., TN (United States)); Tuskan, G.A. National Renewable Energy Lab., Golden, CO (United States). [1995]. DOE Contract AC05-84OR21400. (CONF-9508104–: 2. meeting on biomass of the Americas, Portland, OR (United States), 21-24 Aug 1995). In *Second biomass conference of the Americas: Energy, environment, agriculture, and industry. Proceedings.* 1741p. Order Number DE95009230. Source: OSTI.

For over a decade, researchers have used small-scale research plots to assist development and selection of high yielding, pest-resistant clones of fast-growing hardwoods such as hybrid poplar (Populus spp.). Substantial advances have been made in the techniques and criteria for screening species and selecting clones. Data from these research plots indicate that the ultimate performance of selected clones is dependent upon variable factors in the environment. Until now, researchers could only determine the suitability of a given site for such clones, not the actual yield potential of the site. Recently in the north central United States, several clones were planted on larger-than-research-scale plots on private land recontracted under the Conservation Reserve Program (CRP). The historical database could not provide a framework which would allow producers to predict the yield potential of a particular clone on a specific site. Through a systematic combination of clonal trials on experimental research-scale plots and operational plantings on 50 to 100 acre agricultural-scale field plots, it may be possible to develop yield functions or site quality equations which would predict biomass yields at rotation for selected clones. Such estimates will (1) reduce the probability of planting failure, (2) allow maximum expression of the genetic potential of selected superior clones, and thus (3) facilitate accurate economic planning for both the producer and conversion facility manager.

29213 (NREL/CP–200-8098, pp. 216-225) **Variability in the composition of short rotation woody feedstocks.** Davis, M.F. (National Renewable Energy Lab., Boulder, CO (United States)); Johnson, D.K.; Deutch, S. National Renewable Energy Lab., Golden, CO (United States). [1995]. (CONF-9508104–: 2. meeting on biomass of the Americas, Portland, OR (United States), 21-24 Aug 1995). In *Second biomass conference of the Americas: Energy, environment, agriculture, and industry. Proceedings.* 1741p. Order Number DE95009230. Source: OSTI.

This paper discusses the variability in chemical composition caused by clonal, geographical, and environmental effects on short rotation woody feedstocks, mainly hybrid clones of poplar. The concentrations of major and minor components have been determined by chemical analysis and pyrolysis molecular beam mass spectrometry (PY-MBMS). The chemical composition was determined for a sample set consisting of debarked wood chips from three clones of deltoides x nigra (DN) and one clone of tristis x balsamifera that were grown on four replicate plots at two locations in Wisconsin. The composition of the wood chips determined by chemical analysis and Py-MBMS showed that the tristic clone was significantly different from that of all the DN clones. The composition of the DN clones studied in this sample set were relatively similar to other hybrid poplar samples that have been analyzed over the past three years. The level of compositional variation due to clonal, geographical and environmental factors observed in short rotation woody species to date indicates that they are a consistent and stable feedstock for biofuels production. The effects of storage on different short rotation woody crops has been studied. Results of the analysis of fresh and stored hybrid poplar using traditional wet chemical analysis showed differences in the chemical composition of the feedstocks because of storage. Also presented are results from a rapid analytical technique using pyrolysis-mass spectroscopy combined with multivariate statistical analysis to assess the influence of storage on the composition of different short rotation feedstocks. Because of the rapid nature of this technique, a large number of samples could be screened to determine the extent of degradation throughout the piles. The application of this technique to the samples in this study indicated changes in chemical composition occurred during the storage period.

29214 (NREL/CP–200-8098, pp. 226-234) **Nitrate losses from fertilised short rotation willow - a preliminary evaluation of two years data.** Reynolds, S.E. (WRc, Buckinghamshire (United Kingdom)); Riddell-Block, D.M. National Renewable Energy Lab., Golden, CO (United States). [1995]. (CONF-9508104–: 2. meeting on biomass of the Americas, Portland, OR (United States), 21-24 Aug 1995). In *Second biomass conference of the Americas: Energy, environment, agriculture, and industry. Proceedings.* 1741p. Order Number DE95009230. Source: OSTI.

The contamination of surface and ground waters arising from fertiliser use and livestock husbandry is arousing increasing concern and legislative controls on nitrogen application in vulnerable areas are being applied across the European Union. The production of wood on agricultural land is increasing as farmers diversify away from food crops. One crop which is attracting significant interest amongst farmers is the production of fuel from intensively planted willow and poplar grown on short rotations, referred to as short rotation forestry (SRF). The management of these crops is substantially less intensive than that employed in traditional agriculture. However, concerns over the potential environmental impact of the large-scale development of SRF have prompted the investigation of its water usage and influence on water quality. The opportunity was taken to conduct a preliminary investigation of nitrate leaching losses from intensively planted willow through the monitoring of a trial established to examine the fertiliser response of the crop. Two years data are reported in the poster presentation. Soil pore water samples were collected over two winters using porous ceramic suction samples installed vertically to a depth of 0.75 m beneath 18 month old stools of Salix dasyclados to which 172m^{-3} ha^{-1} equivalent of sewage sludge was applied in May 1993. Samplers were also installed in unfertilised control plots. Stools were spaced to give stocking densities of 20,000, 10,000 and 6,600 ha^{-1}. Sampling commenced in November 1993 and continued at two to four week intervals until the end of May 1994. The process was repeated over the winter of 1994/95. Nitrate concentrations in soil pore water was significantly higher in the fertilised plots than under the unfertilised control in both years. However, differences were no longer significant at the end of the sampling period in either year.

29215 (NREL/CP–200-8098, pp. 235-243) **Productivity of poplar grown on short rotation in Spain: Influence of the rotation age and plant density.** Ciria, M.P. (Centro de Desarrollo de Energias Renovables, Soria (Spain)); Mazon, P.; Carrasco, J. National Renewable Energy Lab., Golden, CO (United States). [1995]. (CONF-9508104–: 2. meeting on biomass of the Americas, Portland, OR (United States), 21-24 Aug 1995). In *Second biomass conference of the Americas: Energy, environment, agriculture, and industry. Proceedings.* 1741p. Order Number DE95009230. Source: OSTI.

The objective of this work is to evaluate the growth potential and biomass productivity of poplar on short rotation for different growth cycles and plant densities in southern Europe. Five poplar clones

have been tested: Unal, Beaupre, Hunnegen, Boelare and Raspalje, all are hybrid clones P. trichocarpa x P. deltoides. For each clone, plant densities of 10000, 5000, 2500 and 1666 trees/ha have been assayed, for growth cycles of 2, 3, 4 and 5 years. The experimentation was initiated in 1986 at Castilla y Leon, region in Spain. The situation of the plantation is 41°36'N and 2°30'E (Greenwich meridiane), at an altitude of 1010 m above the sea level. The average rain precipitation is of about 550 mm/year and the average temperature, 10.5°C. The parameters evaluated for each plant after harvesting have been: total dry weight of the aerial part and dry weight, height and basal diameter of the stems. The highest biomass productivity, next to 20 t/ha.year, was achieved for Raspalje clone, utilizing 10000 trees/ha plantation density and growth cycle of 5 years. Under these conditions the average diameter of the stems was 9.5 cm and the average height of the trees was 7.9 m.

29216 (NREL/CP–200-8098, pp. 244-252) **Higher heating values for pellets made from short rotation biomass of hardwood species.** Chow, P. (Univ. of Illinois, Urbana, IL (United States)); Rolfe, G.L.; Lambert, R.O. Jr. National Renewable Energy Lab., Golden, CO (United States). [1995]. (CONF-9508104–: 2. meeting on biomass of the Americas, Portland, OR (United States), 21-24 Aug 1995). In *Second biomass conference of the Americas: Energy, environment, agriculture, and industry. Proceedings.* 1741p. Order Number DE95009230. Source: OSTI.

The use of pellitized woody biomass for fuel has increased substantially in recent years. The purpose of this study was to determine the higher heating values and ash content on four-year-old short-rotation trees: autumn olive, black alder, cottonwood and sycamore. These plantations were established on marginal agricultural land that was not suitable for food production in Midwestern United States. The effects of tree species, site, and regeneration technique on the fuel value were determined. For comparison purposes, the heat content of three commercial lumber species was also obtained. Test results indicated that the planting sites (bottomland versus upperland) and regeneration method (seeding-grown versus coppice-grown) factors did not affect the higher heating values of all pellitized specimens. The heat values averaged 4728 calories per oven-dry gram, which is greater than the 4580 cal/gram of three commercial hardwoods. The main factor species, as well as the interactions of species by site, species by regeneration, and site by regeneration, were significant factors in determining heat value. Black alder had the highest heat value, followed by autumn olive, cottonwood, and sycamore. Furthermore, a preliminary experiment indicates that alcohol, a liquid fuel, can also be made from the short rotation hardwoods in the laboratory scale. It is likely a pellitized coal product using lignin waste derived from the wood hydrolysis stage of the ethyl alcohol conversion process can also be made in the future.

29217 (NREL/CP–200-8098, pp. 253-260) **Evaluation of switchgrass as a sustainable bioenergy crop in Texas.** Sanderson, M.A. (Texas A&M Univ. Agricultural Research and Extension Center, Stephenville, TX (United States)); Hussey, M.A.; Ocumpaugh, W.R. National Renewable Energy Lab., Golden, CO (United States). [1995]. (CONF-9508104–: 2. meeting on biomass of the Americas, Portland, OR (United States), 21-24 Aug 1995). In *Second biomass conference of the Americas: Energy, environment, agriculture, and industry. Proceedings.* 1741p. Order Number DE95009230. Source: OSTI.

Switchgrass (Panicum virgatum L.) has been selected as a model herbaceous biomass feedstock by the U.S. Department of Energy. Texas A&M University/The Texas Agricultural Experiment Station was selected as one of three Regional Switchgrass Cultivar and Management Testing Centers in 1992 by Oak Ridge National Laboratory. Research in Texas encompasses (1) evaluating switchgrass germplasm at six locations, (2) determining defoliation, fertility, and row spacing response of switchgrass, (3) selecting for differential crown node evaluation and reduced seed dormancy in Alamo switchgrass, (4) basic studies on switchgrass morphology, and (5) response of switchgrass to land application of municipal and agricultural wastes. Research locations span a north-south range of 725 km. We report on results from Objective 1 in this paper. Alamo switchgrass has been one of the best performing cultivars at all locations with yields ranging from 8 to 20 Mg of dry biomass ha^{-1}. Increased production of Alamo in response to N fertilizer was quadratic at Stephenville and linear at Beeville to the highest N rate used of 200 kg ha^{-1}. There was a small response to 20 kg ha^{-1} of P_2O_5 in 1992 at Stephenville, but no response in later years or at Beeville. Row spacing has not had a consistent effect on switchgrass yield. Harvest frequency studies have shown that total seasonal yields are decreased as harvest frequency increases. We have made progress in selecting populations for enhanced and reduced crown node (subcoleoptile internode) elevation and in reduced post harvest seed dormancy.

29218 (NREL/CP–200-8098, pp. 261-266) **The need and potential to further raise switchgrass yields based on 10 years of research in Alabama.** Bransby, D.I. (Auburn Univ., AL (United States)); Sladden, S.E. National Renewable Energy Lab., Golden, CO (United States). [1995]. (CONF-9508104–: 2. meeting on biomass of the Americas, Portland, OR (United States), 21-24 Aug 1995). In *Second biomass conference of the Americas: Energy, environment, agriculture, and industry. Proceedings.* 1741p. Order Number DE95009230. Source: OSTI.

Return per acre (and not cost per ton of biomass) is probably the most important economic driver in the development of a future energy crop industry. Because biomass yield per acre strongly affects return per acre, there is a great need to further raise switchgrass yields. Based on progress in Alabama over the first 10 years, there appears to be considerable potential to achieve this goal. Research started in 1985 with the variety 'Cave-in-Rock'. Average yield from mature stands in these experiments was 3.2 tons/acre. However, in 1987 the potential of an alternate variety called 'Alamo' was recognized. From 1990 to 1994 yield of this variety averaged 11.5 tons/acre, while that of Cave-in-Rock was 4.9 tons/acre. This represented a 135% increase. In a more recent experiment, combined effects on increasing now spacing from 8 to 32 inches and nitrogen fertilizer from 100 to 200 lb/acre, increased yield by another 69%. Since work on breeding and selection of switchgrass for biomass has only just started, and additional progress is likely from improved management/cultural practices, it seems reasonable to expect further yield increases of 50-100% in the next 10 years.

29219 (NREL/CP–200-8098, pp. 267-277) **Compositional variability in herbaceous energy crops.** Johnson, D.K. (National Renewable Energy Laboratory, Golden, CO (United States)); Ashley, P.A.; Deutsch, S.P. National Renewable Energy Lab., Golden, CO (United States). [1995]. (CONF-9508104–: 2. meeting on biomass of the Americas, Portland, OR (United States), 21-24 Aug 1995). In *Second biomass conference of the Americas: Energy, environment, agriculture, and industry. Proceedings.* 1741p. Order Number DE95009230. Source: OSTI.

Before large scale production of biofuels can begin, it is necessary to assess the effect of feedstock variability on biomass conversion. Experiments have been performed to determine the degree of compositional variability in different species of herbaceous energy crops. Considered in these studies were the effects of genetics, growing environment, and plant structure. Analytical pyrolysis-mass spectrometry was used to initially screen the samples. Chemical analysis was performed on selected samples to determine the concentrations of structural (cellulose, hemicellulose, and lignin) and nonstructural (extractives, ash, and protein) components so that summative compositions were obtained. Large differences in composition were found between stems and leaves, with leaves having much higher concentrations of non-structural components. The geographic location where plants were grown was also found to have an impact on composition that transcended differences between varieties. The differences between varieties could not be detected above the variability observed in samples from replicate plots of the same variety, if all samples came from the same location.

29220 (NREL/CP–200-8098, pp. 278-287) **Chemical composition of biomass from tall perennial tropical grasses.** Prine, G.M. (Univ. of Florida, Gainesville, FL (United States)); Stricker, J.A.; Anderson, D.L. National Renewable Energy Lab., Golden, CO (United States). [1995]. (CONF-9508104–: 2. meeting on biomass of the Americas, Portland, OR (United States), 21-24 Aug 1995). In

Second biomass conference of the Americas: Energy, environment, agriculture, and industry. Proceedings. 1741p. Order Number DE95009230. Source: OSTI.

The tall perennial tropical grasses, elephantgrass (Pennisetum purpureum Schum.), sugarcane and energycane (Saccharum sp.) and erianthus (Erianthus arundenaceum (Retz) Jesw.) have given very high oven dry biomass yields in Florida and the warm Lower South USA. No good complete analyses of the chemical composition of these grasses for planning potential energy use was available. We sampled treatments of several tall grass demonstrations and experiments containing high-biomass yielding genotypes of the above tall grass crops at several locations in Florida over the two growing seasons, 1992 and 1993. These samples were analyzed for crude protein, NDF, ADF, cellulose, hemicellulose, lignin, and IVDMD or IVOMD. The analysis for the above constituents are reported, along with biomass yields where available, for the tall grass accessions in the various demonstrations and experiments. Particular attention is given to values obtained from the high-yielding tall grasses grown on phosphatic clays in Polk County, FL, the area targeted by a NREL grant to help commercialize bioenergy use from these crops.

29221 (NREL/CP–200-8098, pp. 288-297) **Energy, economic, and environmental implications of production of grasses as biomass feedstocks.** Downing, M. (Oak Ridge National Lab., TN (United States)); McLaughlin, S.; Walsh, M. National Renewable Energy Lab., Golden, CO (United States). [1995]. DOE Contract AC05-84OR21400. (CONF-9508104–: 2. meeting on biomass of the Americas, Portland, OR (United States), 21-24 Aug 1995). In *Second biomass conference of the Americas: Energy, environment, agriculture, and industry. Proceedings.* 1741p. Order Number DE95009230. Source: OSTI.

Perennial prairie grasses offer many advantages to the developing biofuels industry. High yielding varieties of native prairie grasses such as switchgrass, which combine lower levels of nutrient demand, diverse geographical growing range, high net energy yields and high soil and water conservation potential indicate that these grasses could and should supplement annual row crops such as corn in developing alternative fuels markets. Favorable net energy returns, increased soil erosion prevention, and a geographically diverse land base that can incorporate energy grasses into conventional farm practices will provide direct benefits to local and regional farm economies and lead to accelerated commercialization of conversion technologies. Displacement of row crops with perennial grasses will have major agricultural, economic, sociologic and cross-market implications. Thus, perennial grass production for biofuels offers significant economic advantages to a national energy strategy which considers both agricultural and environmental issues.

29222 (NREL/CP–200-8098, pp. 298-306) **Response of 'Alamo' switchgrass (Panicum virgatum) to weed management practices.** Sledge, S.L. (Auburn Univ., AL (United States)); Walker, R.H. National Renewable Energy Lab., Golden, CO (United States). [1995]. (CONF-9508104–: 2. meeting on biomass of the Americas, Portland, OR (United States), 21-24 Aug 1995). In *Second biomass conference of the Americas: Energy, environment, agriculture, and industry. Proceedings.* 1741p. Order Number DE95009230. Source: OSTI.

Field studies were conducted in 1992 and 1994 to evaluate herbicides that would provide weed control and biomass yield of 'Alamo' switchgrass during the year of establishment. For grass weed control, bensulide was applied preplant incorporated (PPI) at 4.4 kg ai ha^{-1}, while MSMA was applied postemergence over the top (POST) at 2.2 kg ai ha^{-1} to switchgrass that had two to four leaves. Herbicides applied POST for control of broadleaf weed species included 2,4-D at 0.6 kg ai ha^{-1} or metsulfuron at 0.02 kg ai ha^{-1}. Herbicide treatments included bensulide and MSMA applied alone or in combination with s,3-D or metsulfuron. They were arranged in a randomized complete block design and replicated four times. Weed control, crop tolerance and yield data were taken over time. Bensulide or MSMA applied alone provided 80% or greater control of large crabgrass, broadleaf signalgrass and fall panicum for the two years. The addition of metsulfuron or 2,4-D provided acceptable control of smooth pigweed, prickly sida, pitted morningglory and sicklepod. MSMA treatments produced slight PANVI injury that ranged from 20 to 36%. Bensulide injury was mostly moderate ranging from 19 to 88%. Although less injury was recorded with MSMA treatments, bensulide treatments trended higher for establishment-year biomass production that averaged 5123 kg ha^{-1} as compared to 4239 kg ha^{-1} for MSMA treatments.

29223 (NREL/CP–200-8098, pp. 307-312) **Switchgrass as a biofuels feedstock for the upper Southeast.** Parrish, D.J. (Virginia Tech, Blacksburg, VA (United States)); Wolf, D.D.; Balasko, J.A. National Renewable Energy Lab., Golden, CO (United States). [1995]. DOE Contract AC05-84OR21400. (CONF-9508104–: 2. meeting on biomass of the Americas, Portland, OR (United States), 21-24 Aug 1995). In *Second biomass conference of the Americas: Energy, environment, agriculture, and industry. Proceedings.* 1741p. Order Number DE95009230. Source: OSTI.

Switchgrass (Panicum virgatum) has been identified as a promising perennial, herbaceous biofuels feedstock species. It is highly productive, even on marginal sites; but relatively little is known about its management as a potential biofuels feedstock. We no-till planted four varieties (Alamo, Cave-in-Rock, Kanlow, and Shelter) and two breeder's lines (NC1 and NC2) of switchgrass in 1992 and 1993 at eight locations across the upper Southeast (three sites in Virginia, two in Tennessee, and one each in Kentucky, North Carolina, and West Virginia). The plots were fertilized with 100 kg N/ha/yr, and P and K were maintained at high levels based on soil tests. Biomass was harvested once (in late Fall) or twice (in mid-Summer and again in late Fall) per year. The yield data presented here are for the most recent full season (1994). Alamo and Kanlow were among the more productive varieties, averaging 14.3 Mg dry matter per ha across the eight sites and two cutting managements. One site averaged over 20 Mg/ha across varieties and cutting managements. When averaged across all varieties and locations, the two-cut system provided higher yields (15.0 Mg/ha) than a single harvest (11.7 Mg/ha). Shelter and Cave-in-Rock showed a 40% to 50% increase in seasonal total yield when cut twice rather than once, but other varieties and lines responded somewhat less to multiple harvests. Taken together, these data suggest that switchgrass has good potential as a dedicated biofuels feedstock crop in the upper Southeast. The yield differences between genotypes point to potential improvements in productivity, especially if selection is made for biomass production (and not for forage quality). The yield advantage of multiple harvests over a single harvest needs further study to establish whether the higher levels of productivity can be maintained and whether the additional harvests are economic.

29224 (NREL/CP–200-8098, pp. 313-322) **Carbohydrate biofuel I: Rootfuel studies in Mexico, Brazil, Zimbabwe and India.** Shultz, E.B. Jr. (Enable International, Wheaton, IL (United States)); Bragg, W.G. National Renewable Energy Lab., Golden, CO (United States). [1995]. (CONF-9508104–: 2. meeting on biomass of the Americas, Portland, OR (United States), 21-24 Aug 1995). In *Second biomass conference of the Americas: Energy, environment, agriculture, and industry. Proceedings.* 1741p. Order Number DE95009230. Source: OSTI.

"Rootfuel," made by drying the fast-growing starchy-cellulosic taproots of certain members of the family Cucurbitaceae, has been under investigation by us since 1985. Rootfuel can be quickly dried to a much lower level of moisture content than seasoned wood, and also unlike wood, it contains a very small amount of lignin. If it is dry and burned with good draft, it can be burned more slowly than wood with very little smoke production. We studied rootfuel made from Cucurbita foetidissima roots in dry, deforested and well-populated rural lands of Mexico, Brazil, Zimbabwe and India under sponsorship of the Biomass Users Network, with funding from the Rockefeller Foundation. Our purpose was to evaluate rootfuel as a replacement for wood, dung and crop residues to improve indoor air quality for health reasons, and to take pressure off of the remaining trees. Acceptability has been uniformly high. Small test plots have been planted, and new rootfuel species have been identified and tested.

29225 (NREL/CP–200-8098, pp. 333-342) **Carbohydrate biofuels III: Consumptive-use and root yield of buffalo gourd.**

Smeal, D. (New Mexico State Univ., Farmington, NM (United States)); Gregory, E.J.; Tomko, J. National Renewable Energy Lab., Golden, CO (United States). [1995]. (CONF-9508104--: 2. meeting on biomass of the Americas, Portland, OR (United States), 21-24 Aug 1995). In *Second biomass conference of the Americas: Energy, environment, agriculture, and industry. Proceedings.* 1741p. Order Number DE95009230. Source: OSTI.

Biofuel provided by the dried roots of the wild buffalo gourd, Cucurbita foetidissima, represents a potential, cleaner-burning alternative to other biofuels (i.e. wood and coal) currently used for cooking and heating on the Navajo Indian Reservation. However, no information is available regarding the plant's water requirements for growth and viable root production on the Colorado Plateau in northwestern New Mexico where the Navajo Indian Irrigation Project is located. The primary purpose of this study was to evaluate the relationship between buffalo gourd root production and evapotranspiration under variable irrigation as provided by a line-source design. Total dry root yields ranged from 1.6 Mg ha^{-1} (5.1 tons/acre), and increased linearly within an irrigation treatment range of 371 to 927 nm (14.6 to 36.5 in.), respectively. Peak average daily water-use of buffalo gourd providing maximum root yield was 8.6 mm (0.34 in.) and occurred in late July to early August. Results of this study indicate that buffalo gourd can be successfully grown in northwestern New Mexico when irrigated. Other observations during this study suggest that planting rates for optimum root production need to be established.

29226 (NREL/CP–200-8098, pp. 343-349) **Introduction of Miscanthus SSP. in Russia.** Shumny, V.K. (Institute of Cytology and Genetics, Novosibirsk (Russian Federation)); Godovikova, V.A.; Moiseyeva, Y.A. National Renewable Energy Lab., Golden, CO (United States). [1995]. (CONF-9508104--: 2. meeting on biomass of the Americas, Portland, OR (United States), 21-24 Aug 1995). In *Second biomass conference of the Americas: Energy, environment, agriculture, and industry. Proceedings.* 1741p. Order Number DE95009230. Source: OSTI.

In terms of the international program on the development of new plants-sources of raw material and biomass, we have been conducting an all-round study of perennial grasses as refurbishable sources of raw materials for fuels and construction industry, and for recultivation of wastelands and technogenically deteriorated landscapes. Research activity includes: (1) search of the natural Far East population of Miscanthus and Phragmites ssp. for unique ecotypes and the establishment of an original collection of biodiversity for genetic and breeding work; (2) Development of methods for in vitro cultivation of isolated cells and tissues for inducing polymorphism and salt- and coldresistant somaclones and their microprogation; (3) to provide the monitoring of the dynamics of potential bioproduction, establishing experimental plantations for Miscanthus in ecologically different terrains of the Novosibirsk Regions; and (4) optimization of waste-free wood processing techniques with respect to Miscanthus biomass (the production of carboxymethyle cellulose and decoration materials).

29227 (NREL/CP–200-8098, pp. 350-356) **Cell and tissue culture of Miscanthus Sacchariflorus.** Godovikova, V.A. (Institute of Cytology and Genetics, Novosibirsk (Russian Federation)); Moiseyeva, E.A.; Shumny, V.K. National Renewable Energy Lab., Golden, CO (United States). [1995]. (CONF-9508104--: 2. meeting on biomass of the Americas, Portland, OR (United States), 21-24 Aug 1995). In *Second biomass conference of the Americas: Energy, environment, agriculture, and industry. Proceedings.* 1741p. Order Number DE95009230. Source: OSTI.

Since recent time search and introduction of new species of plants have paid attention. More perspective are perennial low maintenance landscape plants from genera Phragmites L. and Miscanthus Anderss. known as high speed growing and great amount of cellulose's containing. Absence of seeds production and limited distribution area prevent from immediately introduction the plants of this species. The main goal of our investigation is the scientific development of the cell and tissue culture methods to get changing clones, salt and cold tolerant plants and their micropogation. At present there are collection of biovariety represented by subspecies, ecotypes and plant regenerants of two species - Miscanthus purpurascens (Anders.) and Miscanthus sacchariflorus (Maxim.). Successful results have been achieved in screening of culture media, prepared on MS base medium and contained a row of tropic components to protect the explant and callus tissue from oxidation and necrosis. Initially the callus was induced from stem segments, apical and nodular meristem of vegetative shoots of elulalia, growing in hydroponic greenhouse. Morphological and cytologic analysis of plant-regenerants have been done.

29228 (NREL/CP–200-8098, pp. 357-365) **Priorities for ecological research of energy crops in the North Central states.** Ugoretz, S.M. (Wisconsin Dept. of Natural Resources, Madison, WI (United States)); Rineer, K.C.; Downing, M. National Renewable Energy Lab., Golden, CO (United States). [1995]. (CONF-9508104--: 2. meeting on biomass of the Americas, Portland, OR (United States), 21-24 Aug 1995). In *Second biomass conference of the Americas: Energy, environment, agriculture, and industry. Proceedings.* 1741p. Order Number DE95009230. Source: OSTI.

Following the principles set by the National Biofuels Roundtable, a workshop was held in March, 1995 which brought together a group of stakeholders and experts in the field of biomass energy and ecology. The mission of the workshop was to identify and set priorities for ecological research to ensure that large-scale biomass energy development in the North Central states occurs in an ecological sound, sustainable manner. The workshop found that questions about the landscape-scale deployment of biomass plantations were most pressing. The workshop recommended that adaptive resource management principles be applied in a phased development of increasingly larger plantations. Each phase of development would help to answer questions about landscape-scale development; improving the design of subsequent phases. Principles of sustainable agriculture should also be applied to biomass plantations to minimize impact on soils and water quality, maintain productivity and benefit the rural economy. Results of the workshop will be helpful to natural resource and research agencies, as well as utilities and biomass energy developers.

29229 (NREL/CP–200-8098, pp. 419-428) **Introduction of the first commercial MASSAHAKE-Plant.** Ahonen, M.A. (VTT Energy, Jyvaskyla (Finland)). National Renewable Energy Lab., Golden, CO (United States). [1995]. (CONF-9508104--: 2. meeting on biomass of the Americas, Portland, OR (United States), 21-24 Aug 1995). In *Second biomass conference of the Americas: Energy, environment, agriculture, and industry. Proceedings.* 1741p. Order Number DE95009230. Source: OSTI.

MASSAHAKE-method is based on integrated harvesting and multi-phased treatment of whole tree chips. The method has been under R&D-work in VTT Energy in Jyvaskyla, Finland since 1987. Main products from this method are high quality raw material for pulp industry and fuel for energy production. One important advantage in using integrated harvesting methods is that they make it possible to carry through silviculturally important first thinnings economically. Also, simultaneously a significant amount of environmentally sound wood fuels become available when using these methods. The MASSAHAKE-method consists mostly of commercially available machines, though some alternations in the original hardware have been done in order to achieve better performance with the method. The main components of the system are chipper, grinder, various sieves and finally an optical sorter. After running the whole tree chips through the process the bark content of raw material fraction is <1% with both birch and pine whole tree chips. The pulp chip yield is >60%, calculated from the chips fed to the process. The remaining 40% of the whole tree chips is considered as fuel fraction, which is suitable for most furnaces as such-no further treatment is needed. Until last year the research has mainly been done in pilot scale and active work was done in order to demonstrate the method in commercial size. Finally the investment decision of the first commercial plant was made and the construction of this plant was completed during the spring of 1995. During normal commercial functions a major research work is done in the plant. The research results will be available for existing and future plants and also the possible inadequancy of the process will be fixed and some further machine development will be done during the two year research project. In this presentation the first experience from the commercial plant and the research results achieved until the end of May 1995 will be presented.

29230 (NREL/CP--200-8098, pp. 976-985) **Estimating the net energy value of corn-ethanol.** Shapouri, H. (Department of Agriculture, Washington, DC (United States)); Duffield, J.; Graboski, M.S. National Renewable Energy Lab., Golden, CO (United States). [1995]. (CONF-9508104--: 2. meeting on biomass of the Americas, Portland, OR (United States), 21-24 Aug 1995). In *Second biomass conference of the Americas: Energy, environment, agriculture, and industry. Proceedings.* 1741p. Order Number DE95009230. Source: OSTI.

Potential air quality benefits and a desire to improve domestic energy security has prompted researchers to investigate the net energy value (NEV) of corn-ethanol. Studies have been conducted in recent years in an attempt to quantify the energy used in growing and converting corn to ethanol. However, variations in data and assumptions among the studies have resulted in a wide range of NEV estimates. The purpose of this study is to identify the factors causing this wide variation and to develop a more consistent NEV estimate. We conclude that the NEV of corn-ethanol is positive when fertilizers are produced by modern processing plants, corn is converted in modern ethanol facilities, farmers achieve normal corn yields and energy credits are allocated to basic coproducts. Our estimate of 16,193 BTU/gal can be considered conservative, since it does not include energy credits for those plants that sell carbon dioxide. Corn ethanol is energy efficient as indicated by an energy ratio of 1.24, i.e., for every BTU dedicated to producing ethanol there is a 24 percent energy gain. Moreover, producing ethanol from domestic corn stocks achieves a net gain in a more desirable form of energy. Ethanol production utilizes abundant domestic feedstocks of coal and natural gas to convert corn into a premium liquid fuel that can replace petroleum imports by a factor of 7 to 1.

29231 (NREL/CP–200-8098, pp. 1008-1016) **Cells on foam and fiber.** Clyde, R. (Clyde Engineering, New Orleans, LA (United States)). National Renewable Energy Lab., Golden, CO (United States). [1995]. (CONF-9508104–: 2. meeting on biomass of the Americas, Portland, OR (United States), 21-24 Aug 1995). In *Second biomass conference of the Americas: Energy, environment, agriculture, and industry. Proceedings.* 1741p. Order Number DE95009230. Source: OSTI.

Cells growing on high area foam and when a screen is put around the foam, it is made heavier so it can be fluidized. When foam is rotated in a half full RBC, drops are formed and mass transfer of oxygen to drops in much faster. Most fungi and some mammalian cells need oxygen. Corrugated fibers with holes in the valleys also produce drops. White rot fungus needs oxygen and it degrades many chlorine compounds, azo dyes, and TNT. Old cardboard boxes are readily available and when buried in soil, oxygen is entrapped. In a lake, the boxes expose high area. Fibers have high surface area for immobilizing cells and when the fibers are rotated, fast reactions occur, converting one chemical to another. Sugar has been fermented to alcohol in 10-15 minutes. Ethanol has high octane and does not need lead. Old cars and trucks still use lead and high levels have been found in the drinking water of several large cities. Bacteria on fibers can remove lead in a few seconds. When an RBC of plain fiber discs is rotated and a light shone in the top the light hits a thin moving film to degrade chlorine compounds. Microbes and light remove sulfur from oil. Calcium magnesium acetate is a non corrosive road deicer. Salt on roads causes millions of dollars damage to bridges and cars. An inexpensive reactor has been made for organization studies of mammalian and plant cells. A magnet is near the bottom but not touching and oxygen is put on the top where there is no seal that can leak.

29232 (NREL/CP–200-8098, pp. 1027-1036) **Sunspuds™: A new sugar crop for producing ethanol fuel.** Barcia, J.F. (JMCA, Inc., Silver Spring, MD (United States)); McCombs, J.M. National Renewable Energy Lab., Golden, CO (United States). [1995]. (CONF-9508104–: 2. meeting on biomass of the Americas, Portland, OR (United States), 21-24 Aug 1995). In *Second biomass conference of the Americas: Energy, environment, agriculture, and industry. Proceedings.* 1741p. Order Number DE95009230. Source: OSTI.

A new proprietary sugar crop called Sunspuds™ has been developed by JMCA, Inc. and is being grown and tested to provide a new commercial energy crop for ethanol production. The question of potential crop superiority has never been answered. Previous technical assessments have shown the crop is easy to grow using planting and harvesting practice with typical potato machine farming. As an ethanol feedstock, the sugar tubers can be broken down easily to solution for a value-added liquid product at the farm gate for export to existing typical refineries. The crop has additional product potential markets for sugar and food, and co-product as feed for cattle. Sunspuds™ grow with little or no fertilization, irrigation, and pest damage. Study results indicate yields of ethanol twice that of corn at similar cost using simple preparation and fermentation processes adaptable to farm operations. Research continues on prototype scale to expand seedstock and establish developing country markets. Objectives of the energy crop development include establishing costs involved in production of ethanol utilizing various options of fermentation for expanded recovery. JMCA, Inc. funding for the development research was provided through the Southeastern Regional Biomass Energy Program (SERBEP) which is administered by the Tennessee Valley Authority (TVA) for the U.S. Department of Energy (DOE); and by the Western Area Power Administration (WAPA) which administers the Western Regional Biomass Energy Program (WRBEP) for U.S. DOE.

29233 (NREL/CP–200-8098, pp. 1037-1047) **Biomass fast pyrolysis.** Bridgwater, T. (Aston Univ., Birmingham (United Kingdom)); Peacocke, C. National Renewable Energy Lab., Golden, CO (United States). [1995]. (CONF-9508104–: 2. meeting on biomass of the Americas, Portland, OR (United States), 21-24 Aug 1995). In *Second biomass conference of the Americas: Energy, environment, agriculture, and industry. Proceedings.* 1741p. Order Number DE95009230. Source: OSTI.

Fast pyrolysis of biomass for liquid fuels is rapidly growing interest in Europe while in North America, interest seems to have peaked a few years ago. This paper summarises the current status of fast pyrolysis activities in both regions and reviews the problems faced by the developers of fast pyrolysis, upgrading and utilisation processes which require resolution if the technologies are to be implemented. Aspects of design of a fast pyrolysis system include feed drying; particle size; pretreatment; reactor configuration; heat supply and transfer; heating rates; reaction temperature; vapour residence time; secondary cracking; char separation; ash separation; liquids collection. Each of these aspects is reviewed and discussed.

29234 (NREL/CP–200-8098, pp. 1048-1058) **Advanced liquid fuel production from biomass for power generation.** Grassi, G. (Zentrum fuer Sonnenenergie, Pisa (Italy)); Palmarocchi, M.; Joeler, J. National Renewable Energy Lab., Golden, CO (United States). [1995]. (CONF-9508104–: 2. meeting on biomass of the Americas, Portland, OR (United States), 21-24 Aug 1995). In *Second biomass conference of the Americas: Energy, environment, agriculture, and industry. Proceedings.* 1741p. Order Number DE95009230. Source: OSTI.

In the European Union, important political decisions recently adopted and concerning the evolution of the Common Agriculture Policy, the GATT trade liberalisation Agreement and new measures actually under discussion (CARBON TAX, Financial support for rural development...) will have significant impact, in a no distant future, on the bioenergy activity. Also the considerable energy import (~ 55% of the consumption) is of increasing concerns. The biomass potential in the E.U. is large, but the availability of commercial technologies for processing and utilising this renewable energy resource is very modest. Thus, a strong effort for the development of new and efficient technologies (like the one implemented by ENEL/CRT) is essential, as well as the build-up of an efficient industry for the commercialisation of reliable, low-cost biomass conversion/utilisation systems. The recently founded "European Bioenergy Industry Association" will make an effort for the promotion of this specific new industrial sector. In this framework, a new research effort (in Germany/Italy) for up-grading the bio-crude-oil by high energetic electrons. This process, if demonstrated feasible, could be of great interest for the production of new liquid fuels of sufficient quality to be utilised in most types of modern power generator.

29235 (NREL/CP–200-8098, pp. 1228-1235) **A new system of harvesting biomass is born.** Sutor, P. (Bayerisches Staatsministerium fur Ernahrung, Munich (Germany)). National Renewable

Energy Lab., Golden, CO (United States). [1995]. (CONF-9508104–: 2. meeting on biomass of the Americas, Portland, OR (United States), 21-24 Aug 1995). In *Second biomass conference of the Americas: Energy, environment, agriculture, and industry. Proceedings.* 1741p. Order Number DE95009230. Source: OSTI.

A new transportable system for harvesting agricultural biomass and converting it into fuel pellets has been designed and operated. It consists of the integrated operations of biomass cutting, particle size reduction, heating, and compression into pellets having a density of about 1.2 kg/L. The system has been demonstrated in the BIOTRUCK 2000. It is the first land vehicle that uses the waste heat of the engine in the pelletizing process.

29236 (NREL/CP–200-8098, pp. 1309-1313) **Responses of Alabama farmers to a survey on growing switchgrass for energy.** Sladden, S.E. (Auburn Univ., AL (United States)); Bransby, D.I. National Renewable Energy Lab., Golden, CO (United States). [1995]. (CONF-9508104–: 2. meeting on biomass of the Americas, Portland, OR (United States), 21-24 Aug 1995). In *Second biomass conference of the Americas: Energy, environment, agriculture, and industry. Proceedings.* 1741p. Order Number DE95009230. Source: OSTI.

A survey was conducted among Alabama farmers to determine (1) what competition switchgrass for energy would face from existing enterprises, (2) how much hay making equipment was already present on farms, and (3) the level of interest among producers in growing switchgrass for energy. Farmers estimated that return/acre for beef cattle from pasture, row crops, hay and forestry (the major agricultural activities in the state) were $69, $110, $50 and $24, respectively. Thirty-two percent of respondents indicated that they had an average of 122 acres idle, while 24% indicated they had an average of 190 acres in the Conservation Reserve Program, for which an average of $39/acre/year was received. Eighty percent of respondents made their own hay and 18% bought hay at an average price of $58/ton. The proportion of respondents that owned equipment was: tractors, 99%; mowers, 80%; hay rakes, 77%; big balers, 68%; and mower-conditioners, 42%. Eighty-four percent indicated that they would produce, harvest, bale and transport biomass themselves, in preference to contracting any part of the operation out. Eight percent indicated that they would plant an average of 155 acres of switchgrass if they could make an average profit of $93/acre/year.

29237 (NREL/CP–200-8098, pp. 1477-1483) **Utilisation of short rotation forestry for on-site boiler fuel.** Sims, R.E.H. (Massey Univ., Palmerston North (New Zealand)); Lowe, H.T. National Renewable Energy Lab., Golden, CO (United States). [1995]. (CONF-9508104–: 2. meeting on biomass of the Americas, Portland, OR (United States), 21-24 Aug 1995). In *Second biomass conference of the Americas: Energy, environment, agriculture, and industry. Proceedings.* 1741p. Order Number DE95009230. Source: OSTI.

A New Zealand meat processing company has planted 100 ha of land adjacent to its plant in short rotation coppice eucalyptus trees for land treatment of the effluent stream (5000+ m^3/day). To be effective this necessitates removal of the accumulate biomass from the site at regular intervals (every 3-4 years). Using the biomass for fuelwood on site could offset the cost of effluent treatment if it could substitute for the existing energy supplies bought into the plant. A wide range of harvesting, drying, processing, storage and conversion options were identified with the objective of using the biomass produced on site to partly displace the coal currently fuelling a 4.2 MW boiler to provide process steam. A computer model was developed to identify the optimum biomass utilisation system from the variety of combinations of options possible including use of contractors. The objective was to match the work capacity of the various equipment components and to minimise the investment payback period for the company. Boiler options to convert or replace the current boiler or to purchase an additional wood-fired boiler were also included. The model was based around the specific requirements of this particular meat plant but it could be adapted to suit other similar short rotation forestry, biomass utilisation schemes.

29238 (NREL/CP–200-8098, pp. 1524-1533) **An evaluation of the performance of integrated bioenergy systems.** Toft, A. (Aston Univ., Birmingham (United Kingdom)); Bridgwater, T.; Mitchell, P. National Renewable Energy Lab., Golden, CO (United States). [1995]. (CONF-9508104–: 2. meeting on biomass of the Americas, Portland, OR (United States), 21-24 Aug 1995). In *Second biomass conference of the Americas: Energy, environment, agriculture, and industry. Proceedings.* 1741p. Order Number DE95009230. Source: OSTI.

A comprehensive study of biomass production conversion and utilisation systems has been carried out to examine complete bioenergy systems from biomass in the forest to electricity delivered to the grid. Models have been derived for all of the key steps in an integrated process which have been compiled into an overall system model. Biomass production from short rotation forestry and from conventional forestry is modelled on an individual operation basis in terms of the performance and cost of each step. This includes planting, maintenance, harvesting, chipping, storage and transport. Biomass conversion includes pretreatment (reception, storage, handling, comminution, screening and drying); atmospheric gasification (generic gasifier, water scrubbing, gas engine); pressure gasification (generic gasifier, hot gas clean-up, gas turbine, HRSG, steam turbine); fast pyrolysis for liquid bio-fuel-oil (pyrolyser, oil storage, dual fuel engine); combustion (fluid bed combustor, steam turbine). Results from the model have been validated and results are included in the paper in terms of electricity production costs at different outputs using each feed and each conversion route. Feed production costs for each case are also included. Further analyses are presented that vary the configuration of a basic system, highlighting the influence of system interfaces on overall production costs. The results show that bio-electricity is only viable with modest incentives, but at larger scales of operation and with the benefits of learning effects on capital costs, bio-electricity will soon be able to compete with conventional electricity without requiring support.

29239 (NREL/CP–200-8098, pp. 1582-1591) **Sustainable biomass energy production and rural economic development using alfalfa as feedstock.** DeLong, M.M. (Northern States Power Company, Minneapolis, MN (United States)); Swanberg, D.R.; Oelke, E.A. National Renewable Energy Lab., Golden, CO (United States). [1995]. (CONF-9508104–: 2. meeting on biomass of the Americas, Portland, OR (United States), 21-24 Aug 1995). In *Second biomass conference of the Americas: Energy, environment, agriculture, and industry. Proceedings.* 1741p. Order Number DE95009230. Source: OSTI.

Alfalfa is a well-known and widely-planted crop that offers environmental and soil conservation advantages when grown as a 4-year segment in a 7-year rotation with corn and soybeans. Alfalfa fixes nitrogen from the air, thereby enhancing soil nitrogen and decreasing the need for manufactured nitrogen fertilizer. With alfalfa yields of 4 dry tons per acre per year and with separate alfalfa leaves being sold as a high-value animal feed, separated alfalfa stems can be economically viable fuel feedstock for a gasifier combined cycle power plant. This paper reports on a feasibility study for an integrated biomass power system, where an energy crop (alfalfa) is coupled to a processing plant and a power plant (integrated gasification combined cycle with hot gas cleanup) in a way that benefits the joint venture of an alfalfa producers cooperative and a utility entity. The sale of a mid-level protein animal feed coproduct and electricity both support the production cost of alfalfa. The co-product/fuel processing operation uses a common train of equipment, thereby requiring neither product to carry the total cost. The power plant provides an important continuous demand for the feedstock and results in continuous supply of leaf product to provide a reliable supply needed for the leaf meal product.

29240 (NREL/CP–200-8098, pp. 1592-1600) **Agro-energy: Redefining energy and agriculture in Iowa.** Cooper, J.T. (Chariton Valley RC&D, Inc., Centerville, IA (United States)). National Renewable Energy Lab., Golden, CO (United States). [1995]. (CONF-9508104–: 2. meeting on biomass of the Americas, Portland, OR (United States), 21-24 Aug 1995). In *Second biomass conference of the Americas: Energy, environment, agriculture, and industry. Proceedings.* 1741p. Order Number DE95009230. Source: OSTI.

Recent advantages in technology are leading to increased interest in agriculture as a source of energy. The replacement of fossil

fuels with biomass is quite feasible in the near future. Investigation of renewable energy in Iowa has centered around the use of agricultural crops to generate electrical energy. Switchgrass, a native grass of Iowa, is one of the most promising biomass producers. Chariton Valley RC&D Inc., a USDA sponsored rural development organization based in southern Iowa and IES Utilities, a major Iowa energy company, are leading a statewide coalition of public and private interests to merge Iowa's agricultural potential with long-term energy requirements to develop a locally sustainable source of biomass fuel. Many of the sois of southern Iowa are best suited to the production of forages and trees. Farm program changes, and the eventual end of the Conservation Reserve Program (CRP) make adding value and establishing long term markets for perennial forage crops vital for the area's continued prosperity. Ten percent of the total land in the four county Chariton Valley area is in CRP – 140,000 acres. Thousands more acres of marginal lands not in CRP, have limited production potential and would be available for biomass production. The associated benefits to water quality, sustainable soil capabilities and the local economy are phenomenal. IES Utilities is working with Iowa State University, R.W. Beck and other private industry interests to identify and develop the technology to convert agricultural crops to energy. The long term plan calls for 35 MW of electrical power production using a dedicated supply of biomass to be established in southern Iowa. This facility would use approximately 30,000 to 40,000 acres. Co-firing biomass with coal appears to provide a short cut to commercial use of biomass and will enhance interest in emerging advanced technologies.

29241 (NREL/CP–200-8098, pp. 1601-1607) **Closed loop biomass in Puerto Rico.** Schroeder, R.M. (Kenetech Resource Recovery, Inc., Gainesville, FL (United States)). National Renewable Energy Lab., Golden, CO (United States). [1995]. (CONF-9508104–: 2. meeting on biomass of the Americas, Portland, OR (United States), 21-24 Aug 1995). In *Second biomass conference of the Americas: Energy, environment, agriculture, and industry. Proceedings.* 1741p. Order Number DE95009230. Source: OSTI.

Kenetech Energy Systems, Inc., began to explore the opportunities for power generation in Puerto Rico in 1993. Among the projects investigated was the development of a power plant that uses biomass for fuel. Through the assistance of a grant from the National Renewable Energy Laboratory, a preliminary study was undertaken to explore various possibilities in biomass production and conversion. The existing sugar cane industry was examined, and various species and regimes of cane species, grass species, and other types of crops were studied. Among the other issues were the political and economic situation, and the uncertainty of the sugar industry in Puerto Rico. A current status of the project is provided.

29242 (NREL/CP–200-8098, pp. 1618-1627) **Ecology of agricultural monocultures: Some consequences for biodiversity in biomass energy farms.** Hoffman, W. (National Audubon Society, Tavernier, FL (United States)); Beyea, J.; Cook, J.H. National Renewable Energy Lab., Golden, CO (United States). [1995]. (CONF-9508104–: 2. meeting on biomass of the Americas, Portland, OR (United States), 21-24 Aug 1995). In *Second biomass conference of the Amencas: Energy, environment, agriculture, and industry. Proceedings.* 1741p. Order Number DE95009230. Source: OSTI.

Most developmental work on biomass crops has involved extensive monocultures of genetically uniform crops. We review the relevant ecology of agricultural monocultures, and some consequences of monocultural methods for the biomass industry. Monocultures can have very high primary productivity; indeed biomass crops are selected for high productivity. The seasonal tempo of productivity is often more punctuated in monocultures than in multispecies system, leaving temporal productivity gaps. In turn, folivorous insect diversity and abundance tends to track the foliage productivity. The productivity gaps may produce bottlenecks in herbivore abundance and diversity. Herbivore population dynamics tend to be less stable in monocultures, driving fluctuations in predator abundance and diversity. These bottlenecks and fluctuations can increase the frequency and severity of pest problems, for herbivorous insects usually respond to productivity increases faster than their predators. The spatial scaling of structural complexity is also critical to habitat value, particularly for vertebrates. At micro scales structural complexity is a function of plant structure. At meso scales, agricultural monocultures tend to be very uniform, compared to multispecies systems, and provide poorer habitat for species needing meso-scale diversity. We suggest three strategies to enhance or restore biodiversity while developing biomass crops. First, tailor the scale of plantings to the needs of wildlife in the system. Second, manage the deployment of the biomass plantings to be complementary to other landscape features. For example, concentrate biomass plantings on the most favorable sites in the landscape, and develop complementary habitat inclusions on poorer microsites. Third, develop crops and crop combinations to benefit wildlife as well as to provide high yields. Select and deploy crops and clones to bridge productivity gaps.

29243 (NREL/CP–200-8098, pp. 1670-1679) **Market projections and factors influencing the development of new products and energy derived from agricultural crops in the European Union.** Knight, B.E.A. (Innovation Management, Cambridge (United Kingdom)); Houghton, T.M. National Renewable Energy Lab., Golden, CO (United States). [1995]. (CONF-9508104–: 2. meeting on biomass of the Americas, Portland, OR (United States), 21-24 Aug 1995). In *Second biomass conference of the Americas: Energy, environment, agriculture, and industry. Proceedings.* 1741p. Order Number DE95009230. Source: OSTI.

Following the 1992 revision of the Common Agricultural Policy in the European Union, it is projected that 25-50 million acres of arable land currently used for food production could be surplus to requirements by 2000. This strategic study was carried out in order to assess factors that will determine, over the next twenty years, the use of a range of crops for non food outlets. Analysis of published research and economic reports and interviews with legislators and opinion leaders in different Member States was carried out. Five defined market sectors were covered: (i) biomass crops for the generation of heat and electricity, (ii) oilseed and cereal crops as sources of transport fuel, (iii) products from vegetable oils, (iv) products from starch and sugar, and (v) products from fibre crops. Opportunities and constraints were ranked and maximum and minimum land use requirements forecast for each sector. Biomass for electricity is projected to need most land, up to 20 million acres by 2015, if all factors are favourable. In the shorter term, crops grown to produce liquid transport fuel are likely to show the most rapid expansion in area. Market demand for environmentally superior products will be a driving force despite, currently, poor relative economics in comparison with fossil fuel derived products. Better integration between crop production and the end markets will be essential.

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Refer also to citation(s) 29199, 29216, 29230, 29234, 29238, 29239, 29240, 29317, 29319, 29334, 29337, 29350, 29357, 29367, 29441, 29958, 29963, 30793

29244 (DOE/CE/15594–T5) **A low energy continuous reactor separator for the production of ethanol from starch, molasses and cellulose. Fifth quarterly report, March 16–June 15, 1995.** Dale, M.C. (Bio-Process Innovation, Inc., West Lafayette, IN (United States)); Hart, F. Bio-Process Innovation, Inc., West Lafayette, IN (United States). [1995]. 8p. Sponsored by USDOE, Washington, DC (United States). DOE Contract FG01-94CE15594. Order Number DE95017702. Source: OSTI; NTIS; GPO Dep.

Progress for the previous quarter is briefly described concerning development of a 24,000 liter continuous stirred reactor-separator pilot plant and a 50 liter pilot plant.

29245 (DOE/CE/15594–T7) **A laboratory and pilot plant scaled continuous stirred reactor separator for the production of ethanol from sugars, corn grits/starch or biomass streams.** Dale, M.C.; Lei, Shuiwang; Zhou, Chongde. Bio-Process Innovation, Inc., West Lafayette, IN (United States). [1995]. 13p. Sponsored by USDOE, Washington, DC (United States);Great Lakes Regional Biomass Energy Program, Madison, WI (United States). DOE Contract FG01-94CE15594. (CONF-9508104–4: 2.

meeting on biomass of the Americas, Portland, OR (United States), 21-24 Aug 1995). Order Number DE96000251. Source: OSTI; NTIS; GPO Dep.

An improved bio-reactor has been developed to allow the high speed, continues, low energy conversion of various substrates to ethanol. The Continuous Stirred Reactor Separator (CSRS) incorporates gas stripping of the ethanol using a recalculating gas stream between cascading stirred reactors in series. We have operated a 4 liter lab scale unit, and built and operated a 24,000 liter pilot scale version of the bioreactor. High rates of fermentation are maintained in the reactor stages using a highly flocculent yeast strain. Ethanol is recovered from the stripping gas using a hydrophobic solvent absorber (isothermal), after which the gas is returned to the bioreactor. Ethanol can then be removed from the solvent to recover a highly concentrated ethanol product. We have applied the lab scale CSRS to sugars (glucose/sucrose), molasses, and raw starch with simultaneous saccharification and fermentation of the starch granules (SSF). The pilot scale CSRS has been operated as a cascade reactor using dextrins as a feed. Operating data from both the lab and pilot scale CSRS are presented. Details of how the system might be applied to cellulosics, with some preliminary data are also given.

29246 (DOE/CE/15594–T8) **The Xylan Delignification Process for biomass conversion to ethanol.** Dale, M.C. (Purdue Univ., Lafayette, IN (United States)); Zhao, C.; Lei, S.; Tyson, G. Environmental Science and Research Foundation, Idaho Falls, ID (United States). [1995]. 20p. Sponsored by USDOE, Washington, DC (United States);National Renewable Energy Lab., Golden, CO (United States);Great Lakes Regional Biomass Energy Program, Madison, WI (United States). DOE Contract FG01-94CE15594. (CONF-950587–3: 17. symposium on biotechnology for fuels and chemicals, Vail, CO (United States), 7-11 May 1995). Order Number DE96000252. Source: OSTI; NTIS; GPO Dep.

An extrusion process melded with alkaline peroxide chemical pretreatements allows the lignin and hemicellulose in biomass to be solublibzed, and the cellulose component to be made available for enzymatic breakdown. This process is called the Xylan Delignification Process (XDP). In this paper, some results of the XDP on promoting enzymatic breakdown and SSF of corn stalks switch grass and straw are reported. It was found that the XDP process allowed quick (6 hour) and reasonably complete (85–88%) hydrolysis of the cellulose fraction of cornstalks, but was less effective in allowing utilization of the switch grass with 76% yeild noted in 24 hours. Solubilization of the lignin and hemicellulose were not acheived on a first set of corn stalk, switch grass, and straw samples, but was noted on a second straw sample.

29247 (DOE/EE–0062) **Methane recovery from animal manures: A current opportunities casebook.** USDOE, Washington, DC (United States). Aug 1995. 100p. Sponsored by USDOE, Washington, DC (United States). Order Number DE95016335. Source: OSTI; NTIS; GPO Dep.

This Casebook examines some of the current opportunities for the recovery of methane from the anaerobic digestion of animal manures US livestock operations currently employ four types of anaerobic digester technology: Slurry, plug flow, complete mix, and covered lagoon. An introduction to the engineering economies of these technologies is provided, and possible end-use applications for the methane gas generated by the digestion process are discussed. The economic evaluations are based on engineering studies of digesters that generate electricity from the recovered methane. Regression models, which can be used to estimate digester cost and internal rate of return, are developed from the evaluations.

29248 (DOE/EE–0063) **Anaerobic digestion of livestock manures: A current opportunities casebook.** Lusk, P.D. USDOE Assistant Secretary for Energy Efficiency and Renewable Energy, Washington, DC (United States). Aug 1995. 10p. Sponsored by USDOE, Washington, DC (United States). Order Number DE95016190. Source: OSTI; NTIS; GPO Dep.

Growth and concentration of the livestock industry creates new opportunities for proper disposal of the large quantities of manures generated at dairy, swine, and poultry farms. One manure management system provides not only pollution prevention but also converts a problem into a new profit center. Economic evaluations and case studies of operating systems indicate that the anaerobic digestion of livestock manures is a commercially-available bioconversion technology with considerable potential for providing profitable co-products, including a renewable fuel. An introduction to the engineering economies of these technologies is provided, based on estimates of digesters that generate electricity from the recovered methane. Regression models used to estimate digester cost and internal rate of return are developed from the evaluations. Case studies of operating digesters, including project and maintenance histories, and the operator's "lessons learned", are provided as a reality check.

29249 (DOE/EE/15623–T2) **Clean energy from municipal solid waste. ERIP Technical progress report No. 2.** Klosky, M. EnerTech Environmental, Inc., Atlanta, GA (United States). 2 Oct 1995. 7p. Sponsored by USDOE, Washington, DC (United States). DOE Contract FG01-95EE15623. Order Number DE96000444. Source: OSTI; NTIS; GPO Dep.

Progress for the period July 1995 – October 1995 for the slurry carbonization plant is described. Topics addressed include analytical results of carbonization of RDF, regression analysis of reactor temperature versus heating value of RDF fuel, and progress on reducing chlorine content of the fuels.

29250 (NREL/CP–200-8098, pp. 110-119) **Processing and utilizing urban wood waste and pallets for fuel.** Smith, M.L. (M.L. Smith Environmental & Associates. Tinley Park, IL (United States)). National Renewable Energy Lab., Golden, CO (United States). [1995]. (CONF-9508104–: 2. meeting on biomass of the Americas, Portland, OR (United States), 21-24 Aug 1995). In *Second biomass conference of the Americas: Energy, environment, agriculture, and industry. Proceedings.* 1741p. Order Number DE95009230. Source: OSTI.

Industry is currently investigating the potential for recovering, processing and utilizing a number of urban waste materials and selected manufacturing waste for fuel. The emphasis is on relatively clean, low ash, high BTU Urban Fuels that might be obtained at substantially reduced cost over conventional fuels. Results from recently completed studies by the Council of Great Lakes Governors Regional Biomass Energy Program, show urban wood waste to be an important source of energy comparing favorably to other urban waste fuels. The GLRBEP Studies, which are reviewed in this paper, examined the types, quantities, current disposition, energy potential and potential markets for urban wood waste in large Metropolitan areas of a five state region including Illinois, Iowa, Minnesota, Ohio and Wisconsin. The studies build on an earlier, 1993 US Forest Products Industry Study which determined facility capital and operating costs for urban wood processing and combustion systems and environmental and regulatory considerations over a range of facility sizes. Net costs to make urban wood fuel available and avoided disposal costs are reviewed. Incentives, methods of sorting and opportunities to salvage urban wood waste and other combustible waste are discussed. Drawing on various studies and Industry experience urban wood fuels are compared to other urban waste fuels.

29251 (NREL/CP–200-8098, pp. 366-371) **The Consortium for Plant Biotechnology Research, Inc.** Schumacher, D. (Consortium for Plant Biotechnology Research, Inc., West Lafayette, IN (United States)). National Renewable Energy Lab., Golden, CO (United States). [1995]. (CONF-9508104–: 2. meeting on biomass of the Americas, Portland, OR (United States), 21-24 Aug 1995). In *Second biomass conference of the Americas: Energy, environment, agriculture, and industry. Proceedings.* 1741p. Order Number DE95009230. Source: OSTI.

The Consortium for Plant Biotechnology Research (CPBR) is a model partnership of universities, industry, and federal laboratories. The CPBR was organized in the U.S. for the purpose of carrying out industrially relevant research and technology transfer. Formed in 1985, it has become a national organization which now includes more than 30 companies and trade associations, 25 universities, and several federal laboratories. Many of the U.S.-based member companies are subdiaries of parent companies that operate internationally. Using a unique competitive process which includes industrial review for relevance and peer review for scientific merit,

the CPBR has sponsored nearly 150 research projects in energy from biomass and plant biotechnology which are resulting in significant industrial gains. research areas include commercial applications of biomass production and conversion with applications to biofuels, biomass power, and environmental improvement and remediation. The CPBR process promotes equal cost-sharing by government and the private sector for the costs of the research. Benefits of CPBR research are leading to significant corporate investments beyond the research costs to bring the results of the research discoveries to the marketplace. The CPBR is currently seeking international partners through interested governmental agencies and other organizations to foster and fund collaborations between international scientists and engineers in both industry and academe.

29252 (NREL/CP–200-8098, pp. 507-514) **Modular plants producing fuels for biomass cogeneration plants.** White, D.H. (Univ. of Arizona, Tucson, AZ (United States)); Wolf, D.; Joyner, H.S. National Renewable Energy Lab., Golden, CO (United States). [1995]. (CONF-9508104–: 2. meeting on biomass of the Americas, Portland, OR (United States), 21-24 Aug 1995). In *Second biomass conference of the Americas: Energy, environment, agriculture, and industry. Proceedings.* 1741p. Order Number DE95009230. Source: OSTI.

Plants with modular sizes of 200 to 600 tons per day of wood feedstock, dry basis, have been designed to produce densified wood fuels to burn in wood-fired steam plants and cogeneration plants. The manufacturing of the densified wood fuel product involves utilizing a higher Btu brittle binder derived from the heavy ends of crude wood oils made by direct liquefaction. The binders range from 15,000 to 16,000 Btu per pound, dry basis. The process also inherently produces a densified pelleted product with essentially no moisture. When sawdust is utilized with these binders, the brittle product can be transported and then crushed to a powder for applications similar to those using powdered coal. A hybrid Extruder-Feeder Liquefaction Fuel/Shredded Biomass Fuel System is proposed for use in biomass cogenerating plants. Preliminary calculations indicate that such a system should be economic where waste disposal problems exist, such that the proposed system allows the use of proven boiler systems now in use for high-Btu clean coal and/or heavy petroleum residue feedstocks.

29253 (NREL/CP–200-8098, pp. 543-552) **MTCI/Thermochem stream reforming process for biomass.** Mansour, M.N. (ThermoChem, Inc., Columbia, MD (United States)); Durai-Swamy, K.; Voelker, G. National Renewable Energy Lab., Golden, CO (United States). [1995]. (CONF-9508104–: 2. meeting on biomass of the Americas, Portland, OR (United States), 21-24 Aug 1995). In *Second biomass conference of the Americas: Energy, environment, agriculture, and industry. Proceedings.* 1741p. Order Number DE95009230. Source: OSTI.

Manufacturing and Technology Conversion International, Inc. (MTCI) has developed a novel technology to convert solid fuels including biomass, coal, municipal solid waste (MSW) and wastewater sludges into usable syngas by steam reforming in an indirectly heated, fluid-bed reactor. MTCI has licensed and patented the technology to ThermoChem, Inc. Both MTCI and ThermoChem have built two modular commercial-scale demonstration units: one for recycle paper mill rejects (similar to refuse-derived fuel [RDF]), and another for chemical recovery of black liquor. ThermoChem has entered into an agreement with Ajinkyatara Cooperative Sugar Factory, India, for building a 10 MW combined cycle power generation facility based on bagasse & agro-residue gasification.

29254 (NREL/CP–200-8098, pp. 553-564) **Development and commercialization of a biomass gasification/power generation system.** Paisley, M.A. (Battelle, Columbus, OH (United States)); Farris, G. National Renewable Energy Lab., Golden, CO (United States). [1995]. (CONF-9508104–: 2. meeting on biomass of the Americas, Portland, OR (United States), 21-24 Aug 1995). In *Second biomass conference of the Americas: Energy, environment, agriculture, and industry. Proceedings.* 1741p. Order Number DE95009230. Source: OSTI.

The US Department of Energy (DOE) has been a leader in the promotion and development of alternative fuel supplies based on renewable energy crops. One promising power generation technology is biomass gasification coupled with either a gas turbine in a combined cycle system or a fuel cell. The gasification of biomass can efficiently and economically produce a renewable source of a clean gaseous fuel suitable for use in these high efficiency power systems or as a substitute fuel in other combustion devices such as boilers, kilns, or other natural gas fired equipment. This paper discusses the development and commercialization of the Battelle high-throughput gasification process for gas turbine based power generation systems. Projected process economics for a gas turbine combined cycle plant are presented along with a description of integrated system operation coupling a 200kW gas turbine power generation system to a 10 ton per day gasifier, and current commercialization activities.

29255 (NREL/CP–200-8098, pp. 586-593) **Thermocatalytic gasification of biomass: Production of methanol, energy in a gas-turbine plant and solid carbon sorbents.** Anikeev, V.I. (Boreskov Institute of Catalysis, Novosibirsk (Russian Federation)); Gudkov, A.V.; Yermakova, A. National Renewable Energy Lab., Golden, CO (United States). [1995]. (CONF-9508104–: 2. meeting on biomass of the Americas, Portland, OR (United States), 21-24 Aug 1995). In *Second biomass conference of the Americas: Energy, environment, agriculture, and industry. Proceedings.* 1741p. Order Number DE95009230. Source: OSTI.

We suggest chemical process schemes (CPS) for a complex biomass conversion to produce methanol and energy. We have modeled these schemes and performed an exergy analysis of their efficiency. Results obtained show the surface isolines for specific productivity towards methanol, exergy efficiency and reduced turbine work. We have found the maxima of target functions within the range of technology parameters studied. We also discuss the global problem of CPS optimization.

29256 (NREL/CP–200-8098, pp. 607-616) **Options for thermochemical processing of biomass.** Spath, P. (National Renewable Energy Lab., Golden, CO (United States)); Tyndall, D. National Renewable Energy Lab., Golden, CO (United States). [1995]. (CONF-9508104–: 2. meeting on biomass of the Americas, Portland, OR (United States), 21-24 Aug 1995). In *Second biomass conference of the Americas: Energy, environment, agriculture, and industry. Proceedings.* 1741p. Order Number DE95009230. Source: OSTI.

With the enactment of the 1990 Clean Air Act Amendments by the United States, comes a new era in energy management, production, and utilization. The demand for cleaner fuels marks the beginning of a new phase in the utilization of alternative fuels in the transportation fuel pool. Thermochemical conversion of biomass can be used to produce transportation fuels and fuel additives such as methanol, mixed alcohols, hydrogen, ethers, gasoline, diesel, and jet fuel. These products can be produced via thermochemical technologies involving gasification or pyrolysis of biomass. Gasification technology produces a synthesis gas consisting primarily of hydrogen, carbon monoxide, carbon dioxide, and water which can be used to make a wide range of products including alcohols, hydrogen, and hydrocarbon fuels. Pyrolysis technology involves pyrolysis of biomass to produce high molecular weight pyrolysis vapors that can be converted into either a refinery feedstock or a thermobiodiesel product. At the National Renewable Energy Laboratory (NREL), stand alone biomass systems are being examined as well as the integration of biomass thermochemical conversion technology with existing facilities. Possibilities exist for integrating with petroleum refineries, natural gas to methanol plants, ethanol plants, coal gasification facilities and pulp and paper mills.

29257 (NREL/CP–200-8098, pp. 617-629) **Gas cleanup for combined cycle power generation using a hot gas conditioning catalyst.** Paisley, M.A. (Battelle, Columbus, OH (United States)); Gebhard, S.C. National Renewable Energy Lab., Golden, CO (United States). [1995]. (CONF-9508104–: 2. meeting on biomass of the Americas, Portland, OR (United States), 21-24 Aug 1995). In *Second biomass conference of the Americas: Energy, environment, agriculture, and industry. Proceedings.* 1741p. Order Number DE95009230. Source: OSTI.

Biomass gasification provides the potential to efficiently and economically produce a renewable source of a clean gaseous fuel

suitable for power generation or synthesis gas (syngas) applications. Biomass as the feedstock for the process is uniquely suited to this application because it provides the means to increase the nation's energy security, and also, to potentially provide a more stable agricultural industry. An important side benefit of the use of biomass is the effective minimization of the primary greenhouse gas, carbon dioxide (CO_2), by providing a means to close-loop the CO_2 cycle. However, high molecular weight hydrocarbon constituents (tar) in the product gas from gasification can complicate the downstream uses of the gas. This paper discusses both the development of a low cost, disposable catalyst system that can eliminate these heavy hydrocarbons from the gas and the use of the catalyst in conjunction with the Battelle high-throughput gasification process for power generation systems.

29258 (NREL/CP–200-8098, pp. 630-636) **Rapid pyrolysis of agricultural residues at high temperatures.** Zanzi, R. (Royal Institute of Technology, Stockholm (Sweden)); Sjoestroem, K.; Bjoernbom, E. National Renewable Energy Lab., Golden, CO (United States). [1995]. (CONF-9508104–: 2. meeting on biomass of the Americas, Portland, OR (United States), 21-24 Aug 1995). In *Second biomass conference of the Americas: Energy, environment, agriculture, and industry. Proceedings.* 1741p. Order Number DE95009230. Source: OSTI.

Agriculture plays an important role in the economy of many countries especially in Latin America. Gasification of agricultural residues such as bagasse from sugar cane for electricity production is a solution to meet energy demands with a favourable effect on the environment. Pyrolysis (heating solid biomass in absence of air to produce solid, liquid or gaseous fuels) is the first step in gasification and combustion. Depending on the conditions the solid, liquid or gaseous products are maximized. The treatment conditions in the pyrolysis determine the char yield and its reactivity in gasification. Char yield and char reactivity are important for the capacity of the gasifier. The rapid pyrolysis of biomass is performed in a free-fall reactor at 850°C. The biomass used in the study was wood (birch) and agricultural residues such as bagasse and leaves both from sugar cane and banana. The reactivity of the char obtained in pyrolysis is determined by reaction with steam in a thermobalance. The low amounts of a highly porous char and the high yield of gaseous products obtained in rapid pyrolysis of bagasse at high temperature are similar to those produced in rapid pyrolysis of wood. Bagasse gives more volatiles and less char than sugar cane residues and banana harvest residues. Bagasse produces a less reactive char after devolatilization than wood. The char obtained by rapid pyrolysis contains a fraction that can be further volatilized by slow pyrolysis. The fraction of char removed by slow pyrolysis is lower in chars from bagasse and sugar cane leaves than in chars from wood. The structures of the chars obtained from birch, bagasse, sugar cane and banana leaves were observed by scanning electron microscope. Qualitative X-ray microanalysis of the chars was made using an electron microscope supplied with an energy dispersive spectrometer. Ca, K, S, Si, Al and Mg were visible on the surface of the chars.

29259 (NREL/CP–200-8098, pp. 647-656) **Constructive features, operation and sizing of fluidized bed gasifiers for biomass.** Gomes, E.O. (Universidad de Oriente, Santiago (Cuba)); Lora, E.S.; Cortez, L.A.B. National Renewable Energy Lab., Golden, CO (United States). [1995]. (CONF-9508104–: 2. meeting on biomass of the Americas, Portland, OR (United States), 21-24 Aug 1995). In *Second biomass conference of the Americas: Energy, environment, agriculture, and industry. Proceedings.* 1741p. Order Number DE95009230. Source: OSTI.

In this paper a few considerations about constructive features, operation and sizing of biomass atmospheric fluidized bed gasifiers are presented. The analysis is carried out on the base of papers and reports on different authors, and also based on the own authors' experience. The state-of-the-art of this technology is presented, as well as the main problems to solve for its wide industrial application. Successful commercial plants are mentioned. A method to calculate main design parameters using recommended values for the air factor, gas superficial velocity and bed temperature is given. The results are the gas, air and biomass flows, the reactor inner diameter and the expanded bed height. Calculations for three different biomass (sugarcane trash and bagasse, and rice husk) are presented.

29260 (NREL/CP–200-8098, pp. 657-675) **Hydrogen from biomass: A fresh approach.** Cox, J.L. (Pacific Northwest Lab., Richland, WA (United States)); Tonkovich, A.Y.; Elliott, D.C. National Renewable Energy Lab., Golden, CO (United States). [1995]. (CONF-9508104–: 2. meeting on biomass of the Americas, Portland, OR (United States), 21-24 Aug 1995). In *Second biomass conference of the Americas: Energy, environment, agriculture, and industry. Proceedings.* 1741p. Order Number DE95009230. Source: OSTI.

A new approach is advanced for the production of hydrogen by the thermochemical gasification of biomass. The process is based on the catalytic steam gasification of biomass with concurrent separation of the hydrogen. The reaction-separation is conducted in a membrane reactor that employs a permselective membrane to separation the hydrogen as it is produced. The process produces a pure (>99.9%) dioxide and steam. Concurrent separation of the hydrogen takes advantage of the Le Chatelier's principle, which enables the gasification to be driven to completion at milder conditions and increases the conversion and hydrogen yield over that predicted by thermochemical equilibrium consideration. Thermodynamic arguments show the energy savings that may be achieved in the gasification is about 30% over conventional gasification technology. Experimental data and thermodynamic arguments are presented that support the projection that high hydrogen yields can be achieved through control of gasification conditions and reactor design. The process is particularly well suited for wet biomass and may be conducted at temperatures as low as 300°C. The process, thermochemistry, preliminary economics, and technology barriers to commercialization are presented.

29261 (NREL/CP–200-8098, pp. 676-684) **Air gasification of lignocellulosic biomass for power generation in Spain: Commercial plants.** Garcia-Bacaicoa, P. (Zaragoza Univ. (Spain)); Bilbao, R.; Uson, C. National Renewable Energy Lab., Golden, CO (United States). [1995]. (CONF-9508104–: 2. meeting on biomass of the Americas, Portland, OR (United States), 21-24 Aug 1995). In *Second biomass conference of the Americas: Energy, environment, agriculture, and industry. Proceedings.* 1741p. Order Number DE95009230. Source: OSTI.

This research team, at Zaragoza University, has worked on biomass (lignocellulosic) gasification and pyrolysis for some years. Its work has been focused towards the development of downdraft moving bed air gasification systems. There is now a cooperation agreement between the company COMA and the Zaragoza University team to develop and market complete installations for electricity production from wastes. Several models have been developed in order to satisfy the needs of each customer (RG-50, 100, 250 and 500, the numbers indicating biomass consumption in kg/h). They can be mobile (built in a container for transportation) or fixed models (to be used "in situ"). Each installation consists of several units: gasifier (downdraft), air supply (blower and air preheater), gas conditioning (cyclone, filter and cooler) and power generation system (Caterpillar set sized for each biomass consumption).

29262 (NREL/CP–200-8098, pp. 809-819) **Biogas utilization.** Moser, M.A. (Resource Conservation Management, Inc., Berkeley, CA (United States)). National Renewable Energy Lab., Golden, CO (United States). [1995]. (CONF-9508104–: 2. meeting on biomass of the Americas, Portland, OR (United States), 21-24 Aug 1995). In *Second biomass conference of the Americas: Energy, environment, agriculture, and industry. Proceedings.* 1741p. Order Number DE95009230. Source: OSTI.

Options for successfully using biomass depend on project scale. Almost all biogas from anaerobic digesters must first go through a gas handling system that pressurizes, meters, and filters the biogas. Additional treatment, including hydrogen sulfide-mercaptan scrubbing, gas drying, and carbon dioxide removal may be necessary for specialized uses, but these are complex and expensive processes. Thus, they can be justified only for large-scale projects that require high-quality biogas. Small-scale projects (less than 65 cfm) generally use biogas (as produced) as a boiler fuel or for fueling internal combustion engine generators to produce electricity. If engines or boilers as selected properly, there should be no need to

remove hydrogen sulfide. Small-scale combustion turbines, steam turbines, and fuel cells are not used because of their technical complexity and high capital cost. Biogas cleanup to pipeline or transportation fuel specification is very costly, and energy economics preclude this level of treatment.

29263 (NREL/CP–200-8098, pp. 911-920) **Hydrogenated soy ethyl ester (HySEE) from ethanol and waste vegetable oil.** Peterson, C. (Univ. of Idaho, Moscow, ID (United States)); Reece, D.; Thompson, J. National Renewable Energy Lab., Golden, CO (United States). [1995]. (CONF-9508104–: 2. meeting on biomass of the Americas, Portland, OR (United States), 21-24 Aug 1995). In *Second biomass conference of the Americas: Energy, environment, agriculture, and industry. Proceedings.* 1741p. Order Number DE95009230. Source: OSTI.

Biodiesel is gaining recognition in the United States as a renewable fuel which may be used as an alternative to diesel fuel without any modifications to the engine. Currently the cost of this fuel is the factor that limits its use. One way to reduce the cost of biodiesel is to use a less expensive form of vegetable oil such as waste oil from a processing plant. These operations use mainly hydrogenated soybean oil, some tallow and some Canola as their frying oils. It is estimated that there are several million pounds of waste vegetable oil from these operations. Additional waste frying oil is available from smaller processors, off-grade oil seeds and restaurants. This paper reports on developing a process to produce the first 945 liters (250 gallons) of HySEE using recipes developed at the University of Idaho; fuel characterization tests on the HySEE according to the ASAE proposed Engineering Practice for Testing of Fuels from Biological Materials, X552; short term injector coking tests and performance tests in a turbocharged, DI, CI engine; and a 300 hour screening test in a single cylinder, IDI, CI engine.

29264 (NREL/CP–200-8098, pp. 961-965) **One-phase methods for accelerating the production of biodiesel methyl esters.** Boocock, D.G.B. (Univ. of Toronto, Ontario (Canada)); Konar, S.K.; Mao, V. National Renewable Energy Lab., Golden, CO (United States). [1995]. (CONF-9508104–: 2. meeting on biomass of the Americas, Portland, OR (United States), 21-24 Aug 1995). In *Second biomass conference of the Americas: Energy, environment, agriculture, and industry. Proceedings.* 1741p. Order Number DE95009230. Source: OSTI.

The base-catalysed (methoxide or hydroxide) methanolysis of vegetable oils (6:1 methanol/oil molar ratio), such as soybean, occurs 15-20 times slower than butanolysis because the former starts out as a two-phase system, in which the solubility of the oil in the methanol phase, where the catalyst is located, is very low. The addition of a cosolvent, such as 1.27 volumes of tetrahydrofuran (THF) per volume of methanol, forms an oil-rich, one phase system in which methanolysis is as fast as butanolysis. Other suitable cosolvents include 1,4-dioxane, diethyl ether and t-butyl methyl ether. THF has a boiling point very close to that of methanol and can be flashed and recycled along with unused alcohol. Glycerol separation usually occurs faster in the presence of cosolvent (4-5 times faster in the case of THF). The sudden and abnormal slowing of both hydroxide and alkoxide transesterifications may be caused by a number of factors including polarity of the mixture, the formation of undesired intermediates and structural differences in the substrates. Simple appropriate measures can dramatically lower 98% conversion times to twenty minutes and less, in which case continuous processes employing centrifuges for glycerol separation become very attractive.

29265 (NREL/CP–200-8098, pp. 966-975) **Biomass-derived oxygenates for transportation fuels.** Wyman, C.E. (National Renewable Energy Laboratory, Golden, CO (United States)). National Renewable Energy Lab., Golden, CO (United States). [1995]. (CONF-9508104–: 2. meeting on biomass of the Americas, Portland, OR (United States), 21-24 Aug 1995). In *Second biomass conference of the Americas: Energy, environment, agriculture, and industry. Proceedings.* 1741p. Order Number DE95009230. Source: OSTI.

The transportation sector in the U.S. is the only element that is almost totally dependent on petroleum for its energy supply. With more than half of all petroleum imported, our transportation, which is vital to the U.S. economy, is very vulnerable to economic and strategic disruptions. With about two-thirds of all oil being used for transportation, it also contributes substantially to the large trade deficit for petroleum imports. Transportation fuels contribute about half the urban air pollution and a third of the carbon dioxide accumulation that could result in global climate change. Because lignocellulosic biomass sources such as agricultural and forestry residues, municipal solid waste, and woody and herbaceous crops could be abundant, production of fuels from biomass could address all these problems on a large scale. Biomass can be gasified by thermal processes to produce a mixture of carbon monoxide and hydrogen that can be catalytically combined to form methanol. Alternatively, the cellulose and hemicellulose in biomass can be broken down to their component sugars for fermentation to ethanol. Although ethanol and methanol are currently most favored for use as transportation fuels, other alcohols could also be formed thermally or biologically from biomass. Ethanol and methanol can be used directly as neat or pure fuels. Ethanol is also directly blended with gasoline to displace gasoline use, increase the octane of the blended fuel, and provide oxygen that insures more complete combustion and reduces the contribution to urban air pollution. The alcohols can be converted into ethers such as ethyl tertiary butyl ether (ETBE) and methyl tertiary butyl ether (MTBE) from ethanol and methanol, respectively. These and other ethers are fully compatible with gasoline, reduce oil use, have favorable vapor pressure effects, boost octane, and provide fuel oxygen.

29266 (NREL/CP–200-8098, pp. 996-1007) **A laboratory and pilot plant scaled continuous stirred reactor separator for the production of ethanol from sugars, corn grits/starch or biomass streams.** Dale, M.C. (Bio-Process Innovation, Inc., West Lafayette, IN (United States)); Lei, S.; Zhou, C. National Renewable Energy Lab., Golden, CO (United States). [1995]. (CONF-9508104–: 2. meeting on biomass of the Americas, Portland, OR (United States), 21-24 Aug 1995). In *Second biomass conference of the Americas: Energy, environment, agriculture, and industry. Proceedings.* 1741p. Order Number DE95009230. Source: OSTI.

An improved bio-reactor has been developed to allow the high speed, continuous, low energy conversion of various substrates to ethanol. The Continuous Stirred Reactor Separator (CSRS) incorporates gas stripping of the ethanol using a recalculating gas stream between cascading stirred reactors in series. We have operated a 4 liter lab scale unit, and built and operated a 24,000 liter pilot scale version of the bioreactor. High rates of fermentation are maintained in the reactor stages using a highly flocculant yeast strain. Ethanol is recovered from the stripping gas using a hydrophobic solvent absorber (isothermal), after which the gas is returned to the bioreactor. Ethanol can then be removed from the solvent to recover a highly concentrate ethanol product. We have applied the lab scale CSRS to sugars (glucose/sucrose), molasses, and raw starch with simultaneous saccharification and fermentation of the starch granules (SSF). The pilot scale CCRS has been operated as a cascade reactor using dextrins as a feed. Operating data from both the lab and pilot scale CSRS are presented. Details of how the system might be applied to cellulosics, with some preliminary data are also given.

29267 (NREL/CP–200-8098, pp. 1017-1026) **Continuous ethanol production in biofilm reactors containing plastic composite rings and discs.** Demirci, A. (Iowa State Univ., Ames, IA (United States)); Pometto, A.L. III; Kai-Lai, G. National Renewable Energy Lab., Golden, CO (United States). [1995]. (CONF-9508104–: 2. meeting on biomass of the Americas, Portland, OR (United States), 21-24 Aug 1995). In *Second biomass conference of the Americas: Energy, environment, agriculture, and industry. Proceedings.* 1741p. Order Number DE95009230. Source: OSTI.

Biofilms are natural forms of cell immobilization in which microorganisms attach to solid supports. At ISU we have developed plastic composite-supports (50% agricultural material, and 50% polypropylene) which stimulate biofilm formation and which can supply micronutrients to the attached microorganism. These plastic supports are produced by twin-screw high temperature extrusion producing ring or discs. For continuous ethanol fermentations with Saccharomyces cerevisiae (ATCC 24859), each packed-bed bioreactors (50 ml) contained plastic composite-rings and -discs, or polypropylene rings (control) with support surface areas of 160

cm^2, and operated at 30°C. For polypropylene rings, cell-washout occurred at dilution rates of 1.9 h^{-1} in 0.6% yeast extract medium, and at 0.48^{-1} in $\geq$0.4% ammonium sulfate medium. With plastic composite-support bioreactors, however, S. cerevisiae at a dilution rate of 1.92 h^{-1} produced 50 g/l/h with 100% expected theoretical conversions of glucose to ethanol. Also, repeated batch fermentations were performed for 11 different composite-supports in medium with varying concentrations of yeast extract to 0% nitrogen. S. cerevisiae with plastic composite-supports whereas with polypropylene supports, ethanol production was reduced significantly. The plastic composite-support blend selected for best performance contained 40% ground soybean hulls, 5% soybean flour, 5% yeast extract, mineral salts, and 50% polypropylene. Therefore, increased productivity in low cost medium can be achieved beyond conventional fermentations by using this novel bioreactor design.

29268 (NREL/CP–200-8098, pp. 1069-1078) **Recycling of treated wood poles.** Fansham, P. (TWT Wood Products, Inc., Alberta (Canada)). National Renewable Energy Lab., Golden, CO (United States). [1995]. (CONF-9508104–: 2. meeting on biomass of the Americas, Portland, OR (United States), 21-24 Aug 1995). In *Second biomass conference of the Americas: Energy, environment, agriculture, and industry. Proceedings.* 1741p. Order Number DE95009230. Source: OSTI.

There are approximately 150 million utilities poles in service in North America. Of the 3 million poles removed from service each year, many poles still contain a sound and structurally intact core and only the outer layer has deteriorated. Since most of the old poles are treated with either pentachlorophenol or creosote there are limited disposal options available to pole users. The practice of giving old poles away to farmers or other interested parties in falling into disfavour since this practice does not absolve the utility of the environmental liability associated with the treated wood. TWT has commercialised a thermolysis (Pyrolysis) based process capable of removing oil based preservatives from treated wood. The patented process involves: the shaving of the weathered pole exterior; the rapid distillation of oil based preservatives in an oxygen depleted environment; condensation of the vapours; and separation of liquids. TWT has constructed a 30,000 pole per year facility east of Calgary and has provided recycled poles for the construction of two power lines now in use by TransAlta Utilities Corporation, Canada's largest investor owned electric utility. TWT has tested two thermolysis (Pyrolysis) technologies and has determined that contact thermolysis using a heated auger design performed better and with less plugging than a fast fluid bed reactor. The fluid bed reactor is prone to coke formation and contamination of the oil by fine char particles. Residual PCP concentration in the shavings was reduced from 9500 ppm to 10 ppm. Leachate testing on the char yielded a PCP concentration of 1.43 ppm in the Leachate, well below the EPA standard maximum of 100 ppm.

29269 (NREL/CP–200-8098, pp. 1089-1098) **Potential production of hydrocarbons from the conversion of a wood-derived oil over some aluminophosphate catalysts.** Bakhshi, N.N. (Univ. of Saskatchewan, Saskatoon (Canada)); Adjaye, J.D. National Renewable Energy Lab., Golden, CO (United States). [1995]. (CONF-9508104–: 2. meeting on biomass of the Americas, Portland, OR (United States), 21-24 Aug 1995). In *Second biomass conference of the Americas: Energy, environment, agriculture, and industry. Proceedings.* 1741p. Order Number DE95009230. Source: OSTI.

A wood-derived oil (WDO) (obtained from ENSYN Technologies Inc.) was converted catalytically over three aluminophosphate catalysts, namely, SAPO-5, SAPO-11 and MgAPO-36. The oil was produced by the Rapid Thermal Processing (RTP) method and its elemental composition was 49.8 wt% C, 7.5 wt% H, and 42.7 wt% O. The catalysts were selected based on their molecular sieving property, acidity and pore size. The test runs were performed in a fixed bed micro-reactor which was operated at 3.6 WHSV and a temperature range of 330-410°C. The objective was to investigate the potential for the production of both liquid and gaseous hydrocarbon products from the conversion of WDO using aluminophosphate catalysts and to determine their performance in liquid product (OLP), aqueous fraction, coke, char and gas. The OLP and gas were the desired products. Between 12-22 wt% of WDO was obtained as OLP. SAPO-5 gave the highest yield of 22 wt% OLP, followed by 19.9 wt% by SAPO-11 and 16.3 wt% by MgAPO-36. The OLP contained an optimum of 61.5, 56.8 and 57.0 wt% (for SAPO-5, SAPO-11 and MgAPO-36, respectively) liquid hydrocarbons. The major products were benzene, n-hexane, heptane and isooctane. All three catalysts were selective for both aromatic and aliphatic hydrocarbons in comparable proportions. On the other hand, in comparison, HZSM-5 was highly selective for aromatic hydrocarbons whereas silica-alumina for selective for mostly aliphatic hydrocarbons. The gas yield was between 8-17 wt% of WDO. Its composition consisted mostly of C_1-C_4 hydrocarbons and CO_2. Among the hydrocarbon gases, ethylene, propane, n-butane and some C_4 olefins were the major products. The catalyst pore size and acidity influenced the yield and product distribution. Also, a detailed comparison with the results obtained with HZSM-5 and silica-alumina catalysts is presented.

29270 (NREL/CP–200-8098, pp. 1099-1109) **Plant variability and bio-fuel properties.** Agblevor, F.A. (National Renewable Energy Lab., Golden, CO (United States)); Besler-Guran, S.; Wiselogel, A.E. National Renewable Energy Lab., Golden, CO (United States). [1995]. (CONF-9508104–: 2. meeting on biomass of the Americas, Portland, OR (United States), 21-24 Aug 1995). In *Second biomass conference of the Americas: Energy, environment, agriculture, and industry. Proceedings.* 1741p. Order Number DE95009230. Source: OSTI.

Thermochemically converting biomass feedstocks to fuels is one of the major thrusts of renewable energy research at the National Renewable Energy Laboratory. Among several thermochemical routes is the fast pyrolysis process which produces liquid fuels from woody and herbaceous biomass feedstocks. Because of the large variability in the composition of biomass feedstocks due to plant variety and environmental factors, it is important to assess how these variabilities affect the properties of thermochemical liquid fuels (bio-oils) produced from these resources. Similar varieties of switchgrass (Panicum virgatum L.) that were grown at three different locations and three hybrid poplar clones that were grown at one location were used in these studies. The feedstocks were pyrolyzed in a fluidized bed reactor at 500°C. The gas products were analyzed on-line and the liquid products were analyzed for elemental composition and higher heating values. Apart from small difference in the yield of char/ash, the yields of pyrolysis oils and gases were similar for switchgrass feedstocks grown at all three locations. The char/ash yields ranged from 21.1 to 22.9%; total liquids (organic liquids + water) yields ranged from 59%-60.5%; and the gas yields ranged from 11%-12% (wt). The higher heating values (HHVs) of the oils were similar (24.3-24.6 MJ/kg). For the hybrid poplar feedstocks, total liquids (65%-69%), char/ash (10%-11%), and gas yields (15.6%-17%) were similar for all three poplar clones; however, the elemental composition and the HHVs of the pyrolysis oils had statistically significant differences. The NC5260 pyrolysis oils had lower HHV (22.0$\pm$0.5 MG/kg) compared to the DN clones (23.2$\pm$0.3 MJ/kg). The yields of total liquids and organics for the three clones were higher than those for the switchgrass feedstocks. The gas yields for the hybrid poplar clones were higher than for the switchgrass, but had compositions similar to those of the switchgrass feedstocks.

29271 (NREL/CP–200-8098, pp. 1151-1160) **Fast pyrolysis of pretreated wood.** Piskorz, J. (Resource Transforms International Ltd, Ontario (Canada)); Radlein, D.; Majerski, P. National Renewable Energy Lab., Golden, CO (United States). [1995]. (CONF-9508104–: 2. meeting on biomass of the Americas, Portland, OR (United States), 21-24 Aug 1995). In *Second biomass conference of the Americas: Energy, environment, agriculture, and industry. Proceedings.* 1741p. Order Number DE95009230. Source: OSTI.

During the 1980's, several research groups reported the fact that pyrolysis in a non-oxidizing atmosphere of wood that had been prehydrolyzed with dilute acid allowed a substantial depolymerization of the cellulose to occur to give anhydrosugars. More recent work has shown that only deionization of the wood is necessary, and not necessarily a partial hydrolysis. The indigineous alkaline inorganic cations contained in the wood (principally calcium and potassium) have a profound effect on the mechanism of thermal

decomposition of the cellulose and hemicellulose fractions. Also, it has been known for many years that alkaline cations are efficient oxidation catalysts for biomass. We have explored the possibility that oxidation reactions in fast pyrolysis of prehydrolyzed, or of deionized, biomass may be altered much more for carbohydrates than for lignins. Results obtained show that fast pyrolysis of pretreated biomass with controlled levels of oxygen will selectively oxidize lignins with relatively little effect on anhydrosugar yields. This partial oxidation approach generated needed heat in situ. As well, by removing a substantial fraction of the lignin-derived material from the pyrolysis liquid, the recovery of anhydrosugars for use as fermentable sugars or as chemicals is simplified.

29272 (NREL/CP–200-8098, pp. 1255-1261) **Biomass in clean coal production.** Knudson, C.L. (Grand Forks Activation Technologies, ND (United States)); Pedersen, M.P. National Renewable Energy Lab., Golden, CO (United States). [1995]. (CONF-9508104–: 2. meeting on biomass of the Americas, Portland, OR (United States), 21-24 Aug 1995). In *Second biomass conference of the Americas: Energy, environment, agriculture, and industry. Proceedings.* 1741p. Order Number DE95009230. Source: OSTI.

In physical cleaning processes for coal, the coal is initially crushed and then cleaned, resulting n a fine clean coal product. The fine nature of this clean coal makes it more difficult to ship and handle. Combining biomass with cleaned coal is one method to produce a dust-free, lump, biomass-coal product that is readily shippable. The University of North Dakota Energy and Environmental Research Center (UND-EERC) in Grand Forks North Dakota has recently completed work funded by the North Dakota Industrial Commission and Knife River coal Mining Company demonstrating that clean coal could be successfully briquetted using biomass (a waste paper filler and a pulverized wheat binder). Grand Forks Activation Technologies (GFAT) is working with Knife River Coal Mining Company in the further development and commercialization of the coal cleaning process. GFAT is also working with Producers Renewable Products, LLC to further develop and commercialize the use of other agricultural waste products, such as stillage concentrate, in the production of biomass-coal fuel products. This process addresses the two problems: (1) how to inexpensively clean centrate water for recycle in an ethanol plant and (2) how to gent an inexpensive binder for reconstitution of coal by pelletization. In the Phase I work, the feasibility of each processing step and end product would be evaluated as well as the overall economic benefits of the process. If successful, it will improve the reconstitution, dewatering, and handling of coal making it a more marketable product. Demonstration of this process would have a number of economic and environmental benefits. The use of cleaned coal as a plant fuel would (1) free up valuable propane or natural gas for use in homes, (2) prevent plant interruptions due to winter demand shut-downs, (3) decrease plant fuel costs, and (4) increase the number of jobs in the local community since coal is a more labor-intensive fuel than natural gas, propane, or oil.

29273 (NREL/CP–200-8098, pp. 1504-1513) **Biomass "Toolkit": A new modelling approach for the evaluation of feasibility and sustainability of bioenergy schemes.** Koukios, E.G. (National Technical Univ., Athens (Greece)); Kyriazis, N.J. National Renewable Energy Lab., Golden, CO (United States). [1995]. Contract JOU2-CT92-0189. (CONF-9508104–: 2. meeting on biomass of the Americas, Portland, OR (United States), 21-24 Aug 1995). In *Second biomass conference of the Americas: Energy, environment, agriculture, and industry. Proceedings.* 1741p. Order Number DE95009230. Source: OSTI.

The complexity of biomass systems acts as an additional constraint in developing and designing feasible and sustainable technologies and processes for the large-scale production of fuels and other non-food products from biological feedstocks. The object of this paper is to present and discuss a new modelling approach, and the corresponding PC-aided tools ("Biomass Toolkit"), making possible the quantitative description of such complex processes and production systems by performing mass and energy balances, as well as other related calculations (of inputs, pollutants, CO_2 effects, other side-effects, etc). This work is based on recent developments in the emerging field of biosystems modelling; biosystems dynamics are described with the help of a minimum number of parameters, having clear physical and/or technical significance; default values of all those parameters are provided to assist the non-expert user. Two types of biosystems are considered, i.e., based on (a) the cultivation of typical energy crops; and (b) the integrated utilization of agricultural residues as biofuels. "Toolkit" is a user-friendly, interactive computer programme, written in Borland C++ language, and operating under Windows PC environment.

29274 (NREL/CP–200-8098, pp. 1557-1571) **Advanced biomass-to-energy conversion technologies for the pulp and paper industry.** Raymond, D.R. (Weyerhaeuser Company, Tacoma, WA (United States)); Kieffer, J.A. National Renewable Energy Lab., Golden, CO (United States). [1995]. (CONF-9508104–: 2. meeting on biomass of the Americas, Portland, OR (United States), 21-24 Aug 1995). In *Second biomass conference of the Americas: Energy, environment, agriculture, and industry. Proceedings.* 1741p. Order Number DE95009230. Source: OSTI.

Driven by process changes that are making pulp and paper mills ever increasingly dependent on purchases electric power, the industry is motivated to search for technology alternatives for the conversion of its biomass residuals to electricity and other useful energy products. Recent emphasis by the U.S. Department of Energy in the area of renewables has provided an unusual window of opportunity for advancing to commercial viability these new, more efficient, energy-generation technologies. This window of opportunity comes at a time when greater than 50% of the industry's power generation equipment will need major alteration or replacement in the next 15 years. Two technologies that can have a profound impact on the industry's energy self sufficiency-even to substantially increasing the capability of exporting electric power-have evolved to the point of commercial readiness. These technologies are biomass gasification combined cycle (BGCC) and black liquor gasification combined cycle (BLGCC). This paper will concentrate on the results of a detailed feasibility study of the integration of BGCC technology with an operating pulp mill and how this technology when combined with emerging BLGCC can and likely will significantly change the future power house configuration of many pulp and paper production facilities. Economic information presented here includes sensitivities to capital support, export power price, feedstock price, plant capacity factor and the plant heat rate. Additional information is contained in the project report presented to NREL and EPRI. Based on analysis of these sensitivities, the factors having by far the most significant impact on BGCC economics are capital cost, the value of export power and fuel cost. Given a 50% shared cost for the first commercial plant, a positive economic result is achievable at export power prices of 5¢/kWh and above.

29275 (NREL/CP–200-8098, pp. 1572-1581) **Successful strategies for bioenergy commercialization: The New York state model.** Peterson, J.M. (New York State Energy Research and Development Authority, Albany, NY (United States)). National Renewable Energy Lab., Golden, CO (United States). [1995]. (CONF-9508104–: 2. meeting on biomass of the Americas, Portland, OR (United States), 21-24 Aug 1995). In *Second biomass conference of the Americas: Energy, environment, agriculture, and industry. Proceedings.* 1741p. Order Number DE95009230. Source: OSTI.

Opportunities exist today for the introduction of innovative technologies to turn a major renewable resource into competitive fuels, chemical and electricity. NYSERDA actively pursues a careful strategy of technology development, financial risk sharing and market-information brokering. A number of important projects are today bridging the gap between research and commercialization: a demonstration plant to convert papermill sludge into levulinic acid is being built in New York; a small independent power producer is demonstrating a down draft wood gasifier to use in conjunction with a natural gas combined cycle plant; and, a 3 MW waste wood power plant is scheduled to be completed in New York City. In each case, NYSERDA played a different role in assisting the drive for commercialization – laboratory research, technical expertise and financial risk sharing and an independent environmental assessment of possible project impacts. The lessons from these projects are many – listen to the marketplace, identify and focus on critical barriers and stay with the project over the long haul. With a call for

market driven research and development, New York State is ready to share the risk of innovative technology commercialization.

29276 (NREL/CP–200-8098, pp. 1608-1617) **Economic development through biomass systems integration in central Florida.** Stricker, J.A. (Univ. of Florida, Gainesville, FL (United States)); Rahmani, M.; Hodges, A.W. National Renewable Energy Lab., Golden, CO (United States). [1995]. (CONF-9508104–: 2. meeting on biomass of the Americas, Portland, OR (United States), 21-24 Aug 1995). In *Second biomass conference of the Americas: Energy, environment, agriculture, and industry. Proceedings.* 1741p. Order Number DE95009230. Source: OSTI.

A biomass to energy system for central Florida was conceptualized with sugarcane as the main feedstock. Additional feedstocks include elephantgrass, leucaena (woody tropical legume), and Eucalyptus. Juice will be pressed from sugarcane and sugars fermented into ethanol with conventional technology. Enough sugarcane will be grown to supply a conventional ethanol plant with juice for a 330 day operating period each yr. Juice will be condensed to 24 degrees Brix for direct conversion during the approximately 100 day harvest season and to 70 degrees Brix for storage and use the remaining 230 days. Residues (mainly lignin), from converting lignocellulosic materials to ethanol, will fuel the plant including evaporators for sugarcane juice. Sugarcane presscake, elephantgrass, leucaena, and Eucalyptus will be feedstocks for the lignocellulose conversion processes. The lignocellulose plant will be sized to convert all sugarcane presscake as it is produced to reduce storage costs. Elephantgrass, leucaena and Eucalyptus will feed the plant outside sugarcane harvest season. The biomass/energy system will produce 123,230,000 L (32,830,000 gal) of ethanol per year with 90% conversion of sugars from juice, hemicellulose, and cellulose to ethanol. Estimated cost of producing ethanol form various feedstocks include: sugarcane $0.25/L ($0.94/gal), elephantgrass $0.30/L ($1.13/gal), 1 leucaena $0.28/L ($1.06/gal), and Eucalyptus $0.28/L (1.07/gal). Future opportunities exist for development of a chemical industry based on lignocellulose materials from biomass.

29277 (NREL/CP–200-8098, pp. 1689-1694) **Biomass in the Netherlands.** Kwant, K.W. Jr. (NOVEM, Utrecht (Netherlands)); Smakman, G.J.J.; Nillesen, F.H.G. National Renewable Energy Lab., Golden, CO (United States). [1995]. (CONF-9508104–: 2. meeting on biomass of the Americas, Portland, OR (United States), 21-24 Aug 1995). In *Second biomass conference of the Americas: Energy, environment, agriculture, and industry. Proceedings.* 1741p. Order Number DE95009230. Source: OSTI.

The energy production from waste and biomass is one of the most promising methods of exploiting renewable energy in the Netherlands. The position of Dutch industry can be improved by means of technological development. An action plan for energy from waste and biomass will be implemented to double the energy output from the present 26 PJ to 54 PJ in 2000. Actions focus on targeted Research and Development with industry and market introduction with the energy production and distribution sector. The government will impose an energy tax (20%) on electricity and natural gas for households. Being a densely populated country the biomass resources originate mainly from waste and residue streams, while as a condition for conversion processes strict environmental regulations have to be met. Landfill gas is widely extracted and converted into energy. Part of the organic fraction of MSW is source separated, digested and upgraded to natural gas quality, while the digestate is used as compost. New development are in the area of cocombustion of wastewood in coal fired power stations. The first plant is under construction. A major R&D programme is set up with industry and research institutes on gasification of residues and biomass. At laboratory and pilotplant scale gasification experiments will be carried out with the different available streams. The major effect will be devoted to blending streams and gas cleaning.

29278 (NREL/CP–200-8098, pp. 1695-1703) **Results of the Finnish bioenergy research programme.** Asplund, D.A. (VTT Energy, Jyvaskyla (Finland)); Helynen, S.A. National Renewable Energy Lab., Golden, CO (United States). [1995]. (CONF-9508104–: 2. meeting on biomass of the Americas, Portland, OR (United States), 21-24 Aug 1995). In *Second biomass conference of the Americas: Energy, environment, agriculture, and industry. Proceedings.* 1741p. Order Number DE95009230. Source: OSTI.

The aim of the Finnish Bioenergy Research Programme for the period 1993-1998 is to increase the use of economically profitable and environmentally sound bioenergy by improving the competitiveness of biofuels. The main research areas are production methods of wood fuels, peat production, use of bioenergy and conversion of biomass to bio-oils. The total funding of the Bioenergy Research Programme is estimated to be 50 million USD which includes the public funding and also funding from the industrial sources. The total number of the projects in 1994 were 60, and 23 of them were at universities and research institutes, 20 industrial and 17 demonstration projects. The integrated harvesting methods, which would produce both wood raw material for pulp mills and wood fuel for energy production, have been further developed and partly demonstrated. The Massahake method, based on several different successive separation phases, has showed a debarking result for birch and bark content below 1% and economical calculations show that the method can be profitable. A full scale Massahake demonstration plant started during the spring 1995. Feeding of solid fuel into high pressure is an essential part of the pressurized power plant processes. Two new pressurized piston feeders, which could substitute lock-hopper systems and high inert gas consumption, have been designed and tested. IGCC (Integrated Gasification Combined Cycle)-concepts for biomass need require a low moisture content of the fuel. A new dryer concept based on a fixed bed dryer ha been developed and tested. In research on conversion technology, new results have been created related to pyrolysis oil and upgrading processes for different pulp industry raw material producing bio-oils. Economical calculations showed that pyrolysis oil could be competitive compared to light fuel oil.

29279 (NREL/CP–200-8098, pp. 1704-1712) **Bavarian program for using renewable energies (biomass-network).** Weber, T. (Bayerisches Staatsministerium fuer Ernaehrung, Munich (Germany)). National Renewable Energy Lab., Golden, CO (United States). [1995]. (CONF-9508104–: 2. meeting on biomass of the Americas, Portland, OR (United States), 21-24 Aug 1995). In *Second biomass conference of the Americas: Energy, environment, agriculture, and industry. Proceedings.* 1741p. Order Number DE95009230. Source: OSTI.

In Bavaria biomass is the most important regenerated resource of energy besides water. For the energetic utilization of biomass the following groups of products should be developed: biogenic fuels (biodiesel, nature diesel), biogas and warmth, steam and electricity based on biomass in small heating plants, heating plants, heating and electricity plants and in combustions of biomass in connection with coal. In a long term the future percentage of biomass used as a resource of energy could be 12%. But in a first step only 5% of the primary energy requirement should be sufficiently supplied with biomass. Biomass as a combustible has a special importance in Bavaria. Therefore residues of forest work, of the utilization of wood, of landscape conservation works, and of the agriculture, such as straw and energy crops are used. For the reason of rationalization within the utilization of biomass a self propelling biotruck, that condenses biomass, was developed. In the next years the state funds of the utilization of biomass as a resource of energy are about 50 Mio DM, available from the Bavarian free state, the Federal Republic of Germany and the EU. These funds are especially assigned for technological furtherances. The funds are directed by CARMEN, an institution founded by the economy and the Bavarian free state for all matters concerning renewable resources. The production and utilization of renewable resources in Bavaria give new tasks to agricultural areas and create new jobs. Moreover many positive effects for the environment and the economic welfare are given.

29280 (NREL/CP–433-7748, pp. 216-226) **MBMS of biomass pyrolysis vapors and catalytic upgrading.** French, R.J. (National Renewable Energy Lab., Golden, CO (United States)); Rejai, B. National Renewable Energy Lab., Golden, CO (United States). Mar 1995. (CONF-9410343–: Applications of free-jet, molecular beam, mass spectrometric sampling conference, Estes Park, CO (United States), 11-14 Oct 1994). In *Applications of free-jet, molecular*

beam, mass spectrometric sampling: Proceedings. 305p. Order Number DE95004052. Source: OSTI; NTIS; GPO Dep.

Studies of the production of transportation fuels from woody plants and other biomass sources at NREL have included the catalytic upgrading of vapors produced by the pyrolysis of wood and other materials. Molecular beam mass spectrometry is uniquely suited to the screening of this chemistry because of its ability to fingerprint the complete slate of pyrolysis or catalysis products in real time. It can also follow transient behavior at the rate of several spectra per second, which is useful in modeling the behavior of a riser-cracker or similar industrial system. Laboratory work was done on a dual-bed vertical reactor in which the sample (3-80 mg of solid sample) is pyrolyzed in the lower section of the reactor and then passed over 0.2-1.0 g of various catalysts. It is then diluted and introduced into the molecular beam. This system can be used to compare various catalysts and feedstocks. In other experiments, a pilot-scale (15kg/hr) pyrolysis plant with catalytic riser cracker was monitored with the NREL transportable MBMS. Continuous sampling was done via an atmospheric pressure, heated line. Nitrogen dilution was used to suppress condensation and water clusters. Results will be shown comparing products from wood, sunflower seeds, and mixtures of paper and plastics. Over MFI zeolite catalyst, a product slate similar to the methanol-to-gasoline process is observed–a mixture of alkane, alkene and aromatic compounds–with additional CO and CO_2. Higher yields of alkenes are produced by the oily and plastic-containing samples. The pilot plant gives spectra similar to the laboratory data. The TMBMS correctly identified improved operating conditions.

29281 (NREL/CP–433-7748, pp. 227-238) **Molecular beam mass spectrometry applied to biomass gasification monitoring.** Gebhard, S.C. (National Renewable Energy Lab., Golden, CO (United States)); Gratson, D.A.; French, R.J. National Renewable Energy Lab., Golden, CO (United States). Mar 1995. (CONF-9410343–: Applications of free-jet, molecular beam, mass spectrometric sampling conference, Estes Park, CO (United States), 11-14 Oct 1994). In *Applications of free-jet, molecular beam, mass spectrometric sampling: Proceedings.* 305p. Order Number DE95004052. Source: OSTI; NTIS; GPO Dep.

The NREL transportable molecular beam mass spectrometer (TMBMS) was successfully used to monitor the composition of unprocessed and catalytically conditioned synthesis gas produced during hog fuel gasification with the Battelle Columbus Laboratory 9 tonne/day indirectly heated biomass gasifier. Variations in biomass feed rate were observed with simultaneous qualitative chemical analysis of the entire gasification product slate. A large number of tar compounds were observed in the unprocessed syngas in addition to the known low molecular weight permanent gases. Tar compounds include a variety of oxygenated and substituted aromatic hydrocarbons, and condensed ring aromatic hydrocarbons. Catalytic conditioning with DN34 effectively destroyed the more reactive oxygenates and stripped off alkyl groups from aromatic rings, but some benzene. naphthalene, phenanthrene/anthracene and pyrene (plus other aromatic hydrocarbons) remained. The concentration of these compounds was estimated to be in the few hundred ppmv range.

29282 (NREL/CP–433-7748, pp. 275-288) **Quantitative sampling with free-jet, molecular beam mass spectrometry.** Wang, D. (National Renewable Energy Lab., Golden, CO (United States)); Meglen, R.; Evans, R.J. National Renewable Energy Lab., Golden, CO (United States). Mar 1995. (CONF-9410343–: Applications of free-jet, molecular beam, mass spectrometric sampling conference, Estes Park, CO (United States), 11-14 Oct 1994). In *Applications of free-jet, molecular beam, mass spectrometric sampling: Proceedings.* 305p. Order Number DE95004052. Source: OSTI; NTIS; GPO Dep.

The MBMS technique is used in the authors' laboratory as a rapid screening tool to provide qualitative information about complex mixtures from high temperature processes. It has been widely applied to the various research projects to develop new technologies for energy conservation and renewable energy. They include thermochemical conversion of biomass, municipal solid waste, and other waste materials to fuels and high value chemicals, plastics recycling, solar destruction of hazardous wastes, employing pyrolysis, catalysis, and sometimes sunlight. It often becomes desirable to know product yields in order to assess the economics of the process under study. Unfortunately, when it comes to quantitative analysis, MBMS has not matched the performance of conventional methods such as GC or GC/MS. The main problem is the interference of peaks from overlapping fragment ions in multicomponent mixtures. In addition, when the MBMS is interfaced with a pyrolysis/catalysis reactor system, it becomes much more difficult to control the whole system well enough to achieve identical performance from one day to the other, or even within the same day. In this paper the authors review several approaches that they have used, with some degree of success, to estimate yields of individual products in a mixture from MBMS data. They are based on calibration methods using a single ion, multiple ions, or the whole mass spectrum. Among the approaches examined are linear least square regression, multiple linear regression (MLR) and principle component regression (PCR). They discuss a few of the major problems encountered in using these methods. The most recent approach to obtaining quantitative analysis with MBMS at NREL is based on partial least squares. The authors present some preliminary results and discuss future plans to realize this approach in practical applications and to generalize it to other environments where MBMS has advantages over conventional techniques.

0910 Properties and Composition

Refer also to citation(s) 29269, 29270, 29278, 29309

29283 (NREL/CP–200-8098, pp. 120-129) **Ash from the combustion of treated wood: Characteristics and management options.** Fehrs, J.E. (C.T. Donovan Associates, Inc., Burlington, VT (United States)); Donovan, C.T. National Renewable Energy Lab., Golden, CO (United States). [1995]. (CONF-9508104–: 2. meeting on biomass of the Americas, Portland, OR (United States), 21-24 Aug 1995). In *Second biomass conference of the Americas: Energy, environment, agriculture, and industry. Proceedings.* 1741p. Order Number DE95009230. Source: OSTI.

Continued research and development of environmentally-acceptable and cost-effective end uses for wood ash is having a significant affect on the ability to use wood and wood waste as fuel. This is particularly true for ash resulting from treated wood combustion. Concerns about the contents of ash from wood containing paint, stain, preservatives, or other chemicals is one of the largest regulatory barriers to its use as fuel. This paper: (1) explains the types of "clean, untreated" and "treated" wood that are likely to produce ash that can be beneficially used; (2) presents preliminary results from a study sponsored by the New York State Energy Research and Development Authority (NYSERDA) on ash characteristics and end uses. The study sampled and analyzed ash generated during test burns of five treated wood wastes at an 18 MW wood-fired power plant; and (3) describes existing and potential end uses for untreated and treated wood ash.

29284 (NREL/CP–200-8098, pp. 840-848) **U.S. biodiesel overview.** Howell, S.A. (National Biodiesel Board, Jefferson City, MO (United States)); Weber, J.A. National Renewable Energy Lab., Golden, CO (United States). [1995]. (CONF-9508104–: 2. meeting on biomass of the Americas, Portland, OR (United States), 21-24 Aug 1995). In *Second biomass conference of the Americas: Energy, environment, agriculture, and industry. Proceedings.* 1741p. Order Number DE95009230. Source: OSTI.

Biodiesel is the mono alkyl esters of long chain fatty acids derived from renewable lipid sources. Through research and market development efforts led by the National Biodiesel Board, government agencies, academia, and private industry, biodiesel is moving toward commercialization as regulations take effect in specific diesel markets and as biodiesel becomes recognized as a practical, low-cost alternative fuel option. Environmentally, biodiesel is biodegradable, non-toxic, and reduces most regulated engine exhaust emissions. Operationally, it performs very similar to petroleum based diesel (petrodiesel) in terms of power, torque, and fuel economy. Biodiesel also offers improved lubricity characteristics compared to petrodiesel. Economically, production and use of biodiesel will enhance both rural and urban economic development.

Also, biodiesel blends can be utilized in vehicle fleets without modifying engines or infrastructure and competes favorably with other alternative fuels on a life cycle cost basis. Market development activities have been, and will continue to be, targeted specific market segments where the attributes of biodiesel justify the price of a premium fuel. More biodiesel production will come on-line as markets are established.

29285 (NREL/CP–200-8098, pp. 849-858) **The biodiesel research programme of New Zealand.** Sims, R.E.H. (Massey Univ., Palmerston North (New Zealand)). National Renewable Energy Lab., Golden, CO (United States). [1995]. (CONF-9508104–: 2. meeting on biomass of the Americas, Portland, OR (United States), 21-24 Aug 1995). In *Second biomass conference of the Americas: Energy, environment, agriculture, and industry. Proceedings.* 1741p. Order Number DE95009230. Source: OSTI.

Research into using triglyceride fuels in compression ignition engines began in New Zealand in the 1970's. The objective was to identify, produce and evaluate a fuel from vegetable oils or animal fats which could be used to power the existing engine fleet without modifications. From a variety of fuels screened, methyl rapeseed oil esters and methyl tallow esters appeared most promising due to their fuel characteristics and their potential availability of supply, tallow being a low value by-product from the export industry equivalent to 10% of the national diesel fuel demand. Short term bench tests and long term road tests of engine performance were conducted for a range of vehicles using neat esters and also blended with diesel. The higher cetane value of tallow esters (> 70) was noteworthy. No technical problems were observed even after extended oil change tests or on turbo-charged engines. Engine wear, after over 200-hours of normal road use, was less than in companion vehicles running on diesel along. Economic analysis of a range of process plant sizes, from 4000 l/year on-farm, to 25,000 m^3/year for a regional plant, showed economies of scale. By-product credits for glycerol and rapeseed meal were included in both commercial and national economic analyses. For tallow esters a single plant of 25,000 m^3/year was preferred to match the national supply of tallow. This would enable a blend of 10% esters/90% diesel to be produced to the current national fuel standard specifications. The programme was concluded in 1989 after having shown triglyceride fuels were technically feasible but not economically competitive. High production costs for rapeseed resulted in esters being double the wholesale diesel price. For tallow esters to be competitive crude oil would need to rise to US$27/barrel. The New Zealand government is currently evaluating means of reducing the national CO_2 levels including that produced by the transport sector.

29286 (NREL/CP–200-8098, pp. 859-868) **A summary of the University of Idaho conference commercialization of biodiesel–establishment of engine warranties.** Peterson, C. (Univ. of Idaho, Moscow, ID (United States)). National Renewable Energy Lab., Golden, CO (United States). [1995]. (CONF-9508104–: 2. meeting on biomass of the Americas, Portland, OR (United States), 21-24 Aug 1995). In *Second biomass conference of the Americas: Energy, environment, agriculture, and industry. Proceedings.* 1741p. Order Number DE95009230. Source: OSTI.

The University of Idaho, Department of Agricultural Engineering with assistance from The National Center for Advanced Transportation, The PNW and Alaska Regional Bioenergy Program, The Idaho Department of Water Resources Energy Division and the ASAE T-11, Energy Committee sponsored an invited, focused workshop on Commercialization of Biodiesel, Establishment of Engine Warranties. Participants were invited from all segments of the Biodiesel industry but engine manufacturer's and users were particularly targeted. Representatives from Detroit Diesel, Navistar, Cummins, Mercedes Benz, the National Biodiesel Board, the Austrian Biodiesel Industry, Link Transportation, Spokane Transit plus other interested research workers and individuals participated in the conference. The conference had two goals (1) development of a brief statement on the current status of the effect of Biodiesel on Engine Warranties (2) development of a strategic plan for making Biodiesel a recognized fuel acceptable by engine manufacturers for use in their engines. This paper will summarize the presentations of the conference, will discuss the draft statement on where we are today on warranty for use of Biofuel and the issues related to warranty which the engine manufacturer's and users developed as part of the conference. A complete proceedings of the warranty conference is available from the National Center for Advanced Transportation Technology at the University of Idaho.

29287 (NREL/CP–200-8098, pp. 1059-1068) **Development of end-market uses for sludge derived oils.** Campbell, H.W. (Wastewater Technology Centre, Ontario (Canada)); Houde, J. Jr.; Mohamed, H.H. El. National Renewable Energy Lab., Golden, CO (United States). [1995]. (CONF-9508104–: 2. meeting on biomass of the Americas, Portland, OR (United States), 21-24 Aug 1995). In *Second biomass conference of the Americas: Energy, environment, agriculture, and industry. Proceedings.* 1741p. Order Number DE95009230. Source: OSTI.

Pyrolytic processes can be utilized to convert organic materials into solid and liquid fuels. The economic viability of most of these processes will be greatly affected by the end-use market for the oil, in terms of both a guaranteed outlet for the product and the potential revenue. Since these oils are not conventional products, significant effort may be required to establish firm markets. The "Oil from Sludge" (OFS) technology developed by the Wastewater Technology Centre (WTC) has been shown to produce oil yields ranging from 10 to 30% (on a dry weight basis) from dried sewage sludge. Efforts over the last several years have focused on developing high-value, non-combustion uses for the oil, primarily in the asphalt industry. Two applications which have shown significant promise are as an asphalt antistripping agent and as an additive for recycling aged asphalt. This paper will focus on the antistripping application. This research has been a joint effort of the WTC, the Canada Centre for Mineral and Energy Technology, the National Research Council of Canada and SNC-Lavalin. The program included preliminary characterization of the sludge derived oil (SDO), laboratory tests to evaluate its potential as an antistripping agent and to determine the effect of SDO on asphalt performance factors, field tests to evaluate engineering properties and a highway test trial on an operating highway. The study included that SDO is an effective antistripping agent and provides protection against moisture induced damage comparable to that achieved with commercial additives. The addition of SDO did not adversely affect the performance of asphalt concrete but did result in increased workability and compaction, and increased resistance to damage by low temperature, rutting and fatigue.

29288 (NREL/CP–200-8098, pp. 1079-1088) **Characteristics of a fast pyrolysis bio-fuel and its miscibility with oxygenated and conventional fuels.** Bakhshi, N.N. (Univ. of Saskatchewan, Saskatoon (Canada)); Adjaye, J.D. National Renewable Energy Lab., Golden, CO (United States). [1995]. (CONF-9508104–: 2. meeting on biomass of the Americas, Portland, OR (United States), 21-24 Aug 1995). In *Second biomass conference of the Americas: Energy, environment, agriculture, and industry. Proceedings.* 1741p. Order Number DE95009230. Source: OSTI.

A bio-fuel produced by ENSYN Technologies Inc. using the RTP method was thoroughly characterized for its pH, specific gravity, viscosity, water content, ash content, alkali content, flash point, vapor pressure, elemental composition, heating value, stability behavior, filterability as well as its distillation and separation characteristics. In addition, its miscibility characteristics with some oxygenated compounds and conventional fuels were investigated. The objective was to determine the essential bio-fuel properties needed for applications such as storage and combustion in turbines. The bio-fuel consisted of 49.8 wt% C, 7.5 wt% H, and 42.7 wt% O. Its flash point was 76°C and heating value was 17.5 MJ/Kg. About 58.0 wt% of Bio-fuel was low boiling fraction (<200°C), 6.0 wt% high boiling fraction (200-450°c) and 36.0 wt% non-volatiles (>450°C). The viscosity and heating value were significantly affected by its water content. The stability of the bio-fuel (studied by monitoring its pH, density, viscosity and distillation characteristics over a 1 year period) changed with time. The bio-fuel was miscible with methanol, ethanol and acetone (oxygenated compounds (OC)). Addition of small amounts of OC decreased its viscosity and density and increased its heating value. The miscibility characteristics of Bio-fuel and Bio-fuel+OC (termed feeds) with Diesel and Bunker C were investigated. Based on 100g of feed, the optimum

amount of Diesel required to obtain stable miscibility over a test period of 24h were: 16g in Bio-fuel, 21 g in Biofuel+Methanol, 25g in Bio-fuel+Ethanol and 19g in Bio-fuel+Acetone. The bio-fuel was miscible with Bunker C in all proportions. Other miscibility studies involving mixtures of WIF (water-insoluble fraction of Bio-fuel)+OC will be discussed. These studies showed that there was a potential for utilizing Bio-fuel directly or indirectly with conventional fuels.

29289 (NREL/CP–200-8098, pp. 1110-1120) **Bio-fuel oil combustion in a 0.5 MW furnace.** Barbucci, P. (ENEL, Pisa (Italy)); Costanzi, F.; Ligasacchi, S. National Renewable Energy Lab., Golden, CO (United States). [1995]. (CONF-9508104–: 2. meeting on biomass of the Americas, Portland, OR (United States), 21-24 Aug 1995). In *Second biomass conference of the Americas: Energy, environment, agriculture, and industry. Proceedings.* 1741p. Order Number DE95009230. Source: OSTI.

Within the framework of a research partially financed by EU, ENEL-CRT has carried out combustion tests on two different kinds of bio-fuel oil derived from the fast pyrolysis of vegetable biomass. The tests have been performed utilizing a multi-purpose test rig, that includes a vertical 0.5 MWt furnace equipped with an industrial swirl-type design burner installed at the top of the combustion chamber. The scope was to compare the behavior of bio-fuel oil with a No.6 fuel oil, in view of investigating on the possible utilization in power systems of this new fuel, in replacement of conventional mineral fuel oils. To that purpose some minor modifications of the existing experimental facility were necessary, in order to adapt the rig to the specific research. The paper presents the encouraging results of the experiments, during which the stable combustion that it was possible to achieve, allowed the monitoring of operating conditions and of flame quality, with particular attention to the thermal furnace load, final O_2, flow rates, pressures and temperatures. Flue gas sampling and analysis of NO_x, CO, SO_2 and CO_2 were also performed, together with solid particulate sampling.

29290 (NREL/CP–200-8098, pp. 1200-1209) **The Designer Pellet project: Clean fuel from urban waste.** Iadarola, C. (Aquasan Network, Inc., Littleton, CO (United States)); Brown, J.R.; Sargent, S.L. National Renewable Energy Lab., Golden, CO (United States). [1995]. (CONF-9508104–: 2. meeting on biomass of the Americas, Portland, OR (United States), 21-24 Aug 1995). In *Second biomass conference of the Americas: Energy, environment, agriculture, and industry. Proceedings.* 1741p. Order Number DE95009230. Source: OSTI.

The "Designer Pellet"(*) project aims at determining the viability of a business in the Denver area to produce clean-burning, high-ash, fuel pellets from the cellulosic component of municipal solid waste. The project is utilizing data from the low-ash (i.e., wood) pellet industry as well as empirical production and environmental data being developed during the course of the project. While the efficiency of such a product depends upon technical considerations, it is also highly dependent on the business climate in which it will operate. The community risk profile is a key element to that. The project will therefore explore external risk factors as well as the perceptual risks of such a project. That assessment will drive the underlying industry assumptions and economics. Project results to data indicate that a waste-based pellet business is potentially viable in the Denver market, dependent on the ability to attract a good partner group. This paper represents a report on the progress of this effort to date, and the requirements for success.

0920 Combustion

Refer also to citation(s) 28663, 29205, 29252, 29258, 29263, 29277, 29279, 29289, 29358

29291 (ETDE/CH-mf–95787322, pp. 73-76) **Fluidized bed reactor for the gasification of biomass.** Sousa, L.C. de (Paul Scherrer Inst. (PSI), Villigen (Switzerland)); Huetter, P.; Mayor, J.C.; Quintilii, M. Paul Scherrer Inst. (PSI), Villigen (Switzerland). 1995. In *Paul Scherrer Institut annual report 1994. Annex V: PSI general energy technology newsletter 1994.* 123p. Source: OSTI; NTIS.

At PSI, an experimental facility was designed to study the gasification of waste biomass. The facility enables investigation of chemical and physical processes taking place in a modern fluidized bed gasifier in a pilot scale of up to 120 kW (max. biomass flow). Research will be focused on the investigation of the behaviour of foreign substances or contaminants (e.g. heavy metals, chlorine etc.) in the gasification process. The fluidized bed gasification facility and its features as well as the accompanying measurement techniques are described. The experimental possibilities and the range of variation of the most important parameters are shown and discussed. (author) 3 figs., 4 tabs., 2 refs.

29292 (NREL/CP–200-8098, pp. 429-438) **Development of gas turbine combustor fed with bio-fuel oil.** Ardy, P.L. (ENEL SpA R&D Dept., Pisa (Italy)); Barbucci, P.; Benelli, G. National Renewable Energy Lab., Golden, CO (United States). [1995]. (CONF-9508104–: 2. meeting on biomass of the Americas, Portland, OR (United States), 21-24 Aug 1995). In *Second biomass conference of the Americas: Energy, environment, agriculture, and industry. Proceedings.* 1741p. Order Number DE95009230. Source: OSTI.

Considering the increasing interest in the utilization of biofuels derived from biomass pyrolysis, ENEL/CRT carried out some experimental investigations on feasibility of biofuels utilization in the electricity production systems. The paper considers the experimental activity for the development and the design optimization of a gas turbine combustor suitable to be fed with biofuel oil, on the basis of the pressurized combustion performance obtained in a small gas turbine combustor fed with bio-fuel oil and ethanol/bio-fuel oil mixtures. Combustion tests were performed using the combustion chamber of a 40 kWe gas turbine. A small pressurized rig has been constructed including a nozzle for pressurization and a heat recovering combustion air preheating system, together with a proper injection system consisting of two dual fuel atomizers. Compressed air allowed a good spray quality and a satisfactory flame instability, without the need of a pilot frame, also when firing crude bio-fuel only. A parametric investigation on the combustion performance has been performed in order to evaluate the effect of fuel properties, operating conditions and injection system geometry, especially as regards CO and NO_x emissions and smoke index.

29293 (NREL/CP–200-8098, pp. 449-460) **Circulating fluidized bed tehnology in biomass combustion-performance, advances and experiences.** Mutanen, K.I. (A. Ahlstrom Corporation, Varkaus (Finland)). National Renewable Energy Lab., Golden, CO (United States). [1995]. (CONF-9508104–: 2. meeting on biomass of the Americas, Portland, OR (United States), 21-24 Aug 1995). In *Second biomass conference of the Americas: Energy, environment, agriculture, and industry. Proceedings.* 1741p. Order Number DE95009230. Source: OSTI.

Development of fluidized bed combustion (FBC) was started both in North America and in Europe in the 1960's. In Europe and especially in Scandinavia the major driving force behind the development was the need to find new more efficient technologies for utilization of low-grade fuels like different biomasses and wastes. Both bubbling fluidized bed (BFB) and circulating fluidized bed (CFB) technologies were under intensive R&D,D efforts and have now advanced to dominating role in industrial and district heating power plant markets in Europe. New advanced CFB designs are now entering the markets. In North America and especially in the US the driving force behind the FBC development was initially the need to utilize different types of coals in a more efficient and environmentally acceptable way. The present and future markets seem to be mainly in biomass and multifuel applications where there is benefit from high combustion efficiency, high fuel flexibility and low emissions such as in the pulp and paper industry. The choice between CFB technology and BFB technology is based on selected fuels, emission requirements, plant size and on technical and economic feasibility. Based on Scandinavian experience there is vast potential in the North American industry to retrofit existing oil fired, pulverized coal fired, chemical recovery or grate fired boilers with FBC systems or to build a new FBC based boiler plant. This paper will present the status of CFB technologies and will compare technical and economic feasibility of CFB technology to CFB technology to BFB and also to other combustion methods. Power plant projects that are using advanced CFB technology e.g. Ahlstrom Pyroflow Compact technology for biomass firing and co-firing of biomass with other fuels will also be introduced.

29294 (NREL/CP–200-8098, pp. 461-469) **Pilot Plant results with Inclined Fluidized Bed technology.** Barlow, J.L. (Barlow Group, Inc., Fort Collins, CO (United States)); Tomberlin, G. National Renewable Energy Lab., Golden, CO (United States). [1995]. (CONF-9508104–: 2. meeting on biomass of the Americas, Portland, OR (United States), 21-24 Aug 1995). In *Second biomass conference of the Americas: Energy, environment, agriculture, and industry. Proceedings.* 1741p. Order Number DE95009230. Source: OSTI.

Studies related to waste wood disposal trends demonstrate a significant need for small scale Biomass combustion units (approximately 2 MW). Conventional stoker technology has demonstrated combustion efficiencies between 60 percent and 99 percent with carbon monoxide emission levels generally ranging between 75 ppm and 500 ppm. Conventional fluidized bed technology has demonstrated combustion efficiencies between 95 percent and 99 percent with nitrogen oxide emissions between 125 ppm and 250 ppm. Through improved agitation of fuel during combustion and improved combustion control, Inclined Fluidized Bed ("IFB") technology can significantly reduce the emission rates of carbon monoxide and nitrogen oxides. Estimates suggest unit sizes as low as 10 mmbtuh are economically feasible while achieving these emission rates. Carbon monoxide emission levels with the IFB technology have ranged between 20 ppm and 100 ppm averaging approximately 30 ppm. IFB nitrogen oxide emission levels have ranged between 125 ppm and 275 ppm. Results of pilot scale testing of a 1,000,000 btuh biomass-fired IFB unit as well as project economics for a full scale prototype will be discussed.

29295 (NREL/CP–200-8098, pp. 470-479) **The PGI biowaste converter-a unique thermal/electrical energy system which operates on solid waste.** McCarroll, R.L. (Power Generating, Inc., Fort Worth, TX (United States)); Partanen, W.E. National Renewable Energy Lab., Golden, CO (United States). [1995]. (CONF-9508104–: 2. meeting on biomass of the Americas, Portland, OR (United States), 21-24 Aug 1995). In *Second biomass conference of the Americas: Energy, environment, agriculture, and industry. Proceedings.* 1741p. Order Number DE95009230. Source: OSTI.

Power Generating, Inc. is developing a unique thermal/electric energy system which is designed to operate on selected types of solid waste. The prime mover in the system is a direct-fired turbocharger with an auxiliary power turbine. This presentation will review overall design and discuss selected equipment components to be incorporated in the prototype system. The presentation will summarize the results of the development work performed to date and outline the program currently underway to demonstrate the technical and economic viability of the system. Potential worldwide markets and ongoing development strategies for the PGI Biowaste Converter will also be discussed.

29296 (NREL/CP–200-8098, pp. 480-482) **Low-emission vortex combustion of biomass and fossil fuel.** Finker, F.Z. (Politechenergo Ltd., St. Petersburg (Russian Federation)); Kubischkin, I.B.; Akhmedov, D.B. National Renewable Energy Lab., Golden, CO (United States). [1995]. (CONF-9508104–: 2. meeting on biomass of the Americas, Portland, OR (United States), 21-24 Aug 1995). In *Second biomass conference of the Americas: Energy, environment, agriculture, and industry. Proceedings.* 1741p. Order Number DE95009230. Source: OSTI.

The article introduces the results of development and industrial experience of low-emission vortex combustion technology (LEVC) of biomass and fossil fuel in industrial and utility boilers in Russian timber and paper industries and Polish power plants. The LEVC technology is based on aerodynamics method of multiple circulation of gases and fuel in the furnaces. LEVC technology accumulates the advantages of conventional and fluidized bed combustion technology. Existing boilers could be easily retrofitted for the application of LEVC technology without requiring major investment. The repowering of boiler with LEVC was the result the reduction NOx emission to the level 170g/GJ without installation additional flue gas cleaning equipment and it gave the opportunity for an injection of sulfur sorbent in the furnace. The authors discussed Russian-Polish experiment on utility boiler retrofitted with the application of LEVC. As the result the efficiency of the boiler increased in 2%. The reduction of the emission is: NOx-40%, SO2-17%.

29297 (NREL/CP–200-8098, pp. 483-492) **Removal of inorganic elements to improve biomass combustion properties.** Jenkins, B.M. (Univ. of California, Davis, CA (United States)); Bakker, R.R.; Wei, J.B. National Renewable Energy Lab., Golden, CO (United States). [1995]. (CONF-9508104–: 2. meeting on biomass of the Americas, Portland, OR (United States), 21-24 Aug 1995). In *Second biomass conference of the Americas: Energy, environment, agriculture, and industry. Proceedings.* 1741p. Order Number DE95009230. Source: OSTI.

Slagging and fouling of boilers remains one of the most important obstacles to the widespread use of herbaceous and annual growth biomass in conventional power plants and steam generators. High concentration of alkali and alkaline earth metals in combination with silica and other compounds leads to the rapid build-up of tenacious deposits on grates and heat exchange surfaces. This study investigates the removal of inorganic compounds prior to firing by relatively simple techniques and discusses potential applications in the biomass power industry. Rice and wheat straw were leached by various techniques, and concentrations of major inorganic species determined in the solid and liquid phases. Total ash contents as well as concentrations of potassium and other alkali and alkaline earth species were reduced substantially. Softening and fusion of the leached fuel ash were observed to occur at higher temperatures than for the untreated fuel ash. Full-scale experiments are pending, but laboratory results suggest that fouling rates should decline for treated fuels compared to untreated fuels in conventional and advanced biomass power systems.

29298 (NREL/CP–200-8098, pp. 493-502) **Willow firing in retrofitted Irish peat plant.** Broek, R. van den (Utrecht (Netherlands)); Faaij, A.; Kent, T. National Renewable Energy Lab., Golden, CO (United States). [1995]. (CONF-9508104–: 2. meeting on biomass of the Americas, Portland, OR (United States), 21-24 Aug 1995). In *Second biomass conference of the Americas: Energy, environment, agriculture, and industry. Proceedings.* 1741p. Order Number DE95009230. Source: OSTI.

Interest in biomass electricity in Ireland is being re-awakened by environmental concerns about CO_2 emissions from power generation and the potential of biomass production to provide an alternative agricultural enterprise. The technical and economical feasibility of wood-fuelled power production using willow from energy farming in existing peat-fired plants in Ireland is being studied within the framework of the EU JOULE II+ programme. These options are compared with new combustion plants and a biomass integrated gasifier with combined cycle (BIG/CC). Background studies supplied data for yields of willow farming, establishment of willow plantations, harvesting methods, logistics and costs and efficiencies for different retrofit options at Irish peat plants. All technologies considered are currently available or are expected to be available in the near future. Neither agricultural subsidies nor possible CO_2 taxes have been included. In the least cost supply scenario storage and chipping of wood is done at the power station. In this case wood is only stored in the form of sticks and wood harvested by a chips harvester is supplied to the plant directly during the harvesting season. Fuel costs at the plant gate were estimated between 3.3 and 11 EGU/GJ_{LHV}. This wide range resulted in a wide range of kWh costs. For the lowest cost option they ranged between 5.4 and 15 ECUcents/kWh. The cheapest proven retrofit option is the conversion of the existing milled peat Lanesborough unit 3 into a bubbling fluidized bed with kWh costs ranging from 5.6 up to 16 ECUcents/kWh. For this plant, costs per tonne of avoided CO_2 emissions varied between 1 and 70 ECU. It is noteworthy that the kWh costs for all options considered were very close. Especially in the high costs scenario a BIG/CC appeared to have lower kWh cost than all biomass combustion plants. Mainly for the retrofitted plants the fuel costs were by far the largest kWh cost component.

29299 (NREL/CP–200-8098, pp. 503-506) **The layer-flame method of bark burning.** Fincker, F.Z. (Polytechenergo ltd, St. Petersburg (Russian Federation)); Rundygin, Y.A.; Kubyshkin, I.B. National Renewable Energy Lab., Golden, CO (United States). [1995]. (CONF-9508104–: 2. meeting on biomass of the Americas,

Portland, OR (United States), 21-24 Aug 1995). In *Second biomass conference of the Americas: Energy, environment, agriculture, and industry. Proceedings.* 1741p. Order Number DE95009230. Source: OSTI.

At the present time many countries including Russia have at their disposal a considerable number of abled boiler installations designed for an utilization of different biomasses and wastes of the timber industry (such as peat, bark, sawdust, chips and so on). The traditional technology of burning with the application of layer or flame processes, especially in case of unstable heat-technical characteristics of a fuel to be used does not guarantee a reliable and economical performance of a boiler installation. For example, dampness of bark used in enterprises of the pulp and paper industry as an energetic fuel may vary from 50 till 70 per cent during a short period of time. Operation of the boiler installation is also complicated by variable composition of a fuel. Fuel particles may be either very small or very coarse, that is, they may differ from one another, according to their sizes, by thousand times. To flatten the heat-technical and fractional characteristics of a fuel there is used a difficult and cumbersome equipment the performance of which is complicated by the possibility that some of coarse metallic or mineral fractions can penetrate together with a fuel into the process. There is needed a search for new ways of updating the efficiency of energetic application of such fuels. Investigations of this problem are being carried out in a few directions including different variations of thermal treatment of the described material (pyrolysis, gasification and so on). A lot of works is connected with the exploration of boiler installations equipped with diverse modifications of the fluid bed furnaces. However, as a result of their having proven to be too expensive, difficult to create, unreliable and for they also take too much electricity on their own needs, these furnaces have not yet found wider spreading as for the burning of such hard-combustible fuels as bark and other highly damp wastes of timber industry.

29300 (NREL/CP–200-8098, pp. 533-542) **Power production based on biofuels.** Nielson, L. (ELSAM, Fredericia (Denmark)); Nielson, C. National Renewable Energy Lab., Golden, CO (United States). [1995]. (CONF-9508104–: 2. meeting on biomass of the Americas, Portland, OR (United States), 21-24 Aug 1995). In *Second biomass conference of the Americas: Energy, environment, agriculture, and industry. Proceedings.* 1741p. Order Number DE95009230. Source: OSTI.

The poster is a presentation of the Danish Biomass Programme, relating ELSAM incentives to burn biofuels in power plants and ELSAM activities to that end. ELSAM is one of the two power pools dividing Denmark into east and west. Due to government demands, ELSAM has to burn approx. 600,000 tonnes of straw and 100,000 tonnes of wood chips by the year 2000, equivalent to approx. 10 PJ or 8% of ELSAM's power production. To achieve the national CO_2 goal-20% reduction by the year 2005-ELSAM plans to utilise biofuels to the equivalent of approx. 25 PJ or 15% of ELSAM's power production. ELSAM activities aim at the following goals for CO_2 reduction: identification of suitable biofuels (straws, mischantus, wood chips, etc.); co-firing of coal and straw in 150-250 MW pulverized fuel units; commercialisation of 100-250 MW 50-100% biofuel-fired power plants; increased efficiency on coal-fired plants through ultra super critical cycle; gasification of biofuels and coal; natural gas firing in existing or new units. The natural gas firing solution will not be debated any further. The poster carries information and related topics of the 9th European Bioenergy Conference, scheduled to take place on June 24-28, 1996 in Copenhagen.

29301 (NREL/CP–200-8098, pp. 576-585) **The THERMIE targeted projects on biomass gasification.** Maniatis. K. (European Commission, Brussels (Belgium)); Ferrero, G.L. National Renewable Energy Lab., Golden, CO (United States). [1995]. (CONF-9508104–: 2. meeting on biomass of the Americas, Portland, OR (United States), 21-24 Aug 1995). In *Second biomass conference of the Americas: Energy, environment, agriculture, and industry. Proceedings.* 1741p. Order Number DE95009230. Source: OSTI.

The Directorate General for Energy of the European Commission initiated a targeted activity on the Gasification of Biomass for the Production of Electricity and Heat within the framework of the THERMIE programme. After a call for proposals, three demonstration projects were approved for financial support by the Commission being the "BIOCYCLE" in Denmark, the "ENERGY FARM" in Italy and "ARBRE" in the United Kingdom. In total eight national or regional utilities as well as seven major engineering companies from the European Union are participating in the three consortia formed to carry out the projects. All three projects have been initiated and are at the design phase. The three projects are based on IGCC with advanced biomass gasification technologies and amongst them cover most technologically significant areas such as atmospheric and pressurised operation, hot gas cleaning system, catalytic tar cracking and scrubbing of the fuel gas. The same gas turbine will be used for the three projects. The net output capacity ranges from 7 to 11.9 MWe while for the BIOCYCLE project the sale of heat to a district heating network will be demonstrated too. For the majority of the supply of the resource, short rotation forestry (SRF) will be used based mostly on poplar and willow species, while for the balance, forest residues and/or wood from the forest industry will be used. The application of sludge to improve the yield from the SRF will be demonstrated by the ARBRE project. The area of the energy plantations ranges from 1,300 to 3,600 ha.

29302 (NREL/CP–200-8098, pp. 869-881) **Emissions and engine performance from blends of soya and canola methyl esters with ARB No. 2 diesel in a DDC 6V92TA MUI engine.** Spataru, A. (ADEPT Group, Inc., Los Angeles, CA (United States)); Romig, C. National Renewable Energy Lab., Golden, CO (United States). [1995]. (CONF-9508104–: 2. meeting on biomass of the Americas, Portland, OR (United States), 21-24 Aug 1995). In *Second biomass conference of the Americas: Energy, environment, agriculture, and industry. Proceedings.* 1741p. Order Number DE95009230. Source: OSTI.

A Detroit Diesel 6V92TA MUI engine was operated on several blends of EPA No. 2 diesel, soya methyl ester (SME) and canola methyl ester (CME). Various fuels and fuel blend characteristics were determined and engine emissions from these fuels and blends were compared. Increasing percentages of SME and CME blended with either ARB or EPA diesels led to increased emissions of NO_x, CO_2 and soluble particulate matter. Also noted were reductions in total hydrocarbons, CO and insoluble particulate matter. Chassis dynamometer tests conducted on a 20/80 SME/ARB blend showed similar emission trends. The data suggest that certain methyl ester/No. 2 diesel blends in conjunction with technologies that reduce the soluble fraction of particulate emissions merit further exploration as emissions reducing fuel options for North American mass transit sectors (except California, which mandates ARB diesel).

29303 (NREL/CP–200-8098, pp. 882-892) **Cummins 5.9L biodiesel fueled engines.** Schumacher, L.G. (Univ. of Missouri, Columbus, MO (United States)); Hires, W.G.; Krahl, J.G. National Renewable Energy Lab., Golden, CO (United States). [1995]. (CONF-9508104–: 2. meeting on biomass of the Americas, Portland, OR (United States), 21-24 Aug 1995). In *Second biomass conference of the Americas: Energy, environment, agriculture, and industry. Proceedings.* 1741p. Order Number DE95009230. Source: OSTI.

The Agricultural Engineering Department at the University of Missouri-Columbia has fueled a 1991 and a 1992 Dodge pickup Cummins engine with 100 percent methyl-ester soybean oil (biodiesel) for more than 172,545 km (107,215 mile). The 1991 pickup has been driven 89,888 km (55,854 mile) and the 1992 pickup has been driven approximately 82,658 (51,361 mile). Fueling the 5.9 L (360 in^3) engines with 100% biodiesel initially increased engine power by 3% (1991 engine) and reduced power by 7% (1992 engine). However, both pickups produced less power while fueled on biodiesel during the last series of chassis dynamometer testing. The pickups averaged 6.9 km/L (16.6 mil/gal). Analysis of engine lubrication oil showed that the engines were wearing at a normal rate. Black exhaust smoke normally observed when a diesel engine accelerates was reduced when the diesel engine was fueled with 100% biodiesel. Increased EPA exhaust emissions requirements for diesel engines have created much interest in the use of biodiesel as a fuel for diesel engines.

29304 (NREL/CP–200-8098, pp. 893-901) **An alternative fuel for urban buses-biodiesel blends.** Schumacher, L.G. (Univ. of Missouri, Columbia, MO (United States)); Weber, J.A.; Russell, M.D. National Renewable Energy Lab., Golden, CO (United States). [1995]. (CONF-9508104–: 2. meeting on biomass of the Americas, Portland, OR (United States), 21-24 Aug 1995). In *Second biomass conference of the Americas: Energy, environment, agriculture, and industry. Proceedings.* 1741p. Order Number DE95009230. Source: OSTI.

Qualitative and quantitative biodiesel fueling performance and operational data have been collected from urban mass transit buses at Bi-State Development Agency in St. Louis Missouri. A total of 10 vehicles were selected for fueling; 5-6V92 TA Detroit Diesel engines have been fueled with a 20/80 biodiesel/diesel fuel blend and 5-6V92 TA Detroit Diesel control vehicles have been fueled on petroleum based low sulfur diesel fuel (LSD). The real-world impact of a biodiesel blend on maintenance, reliability, cost, fuel economy and safety compared to LSD will be presented. In addition, engine exhaust emissions data collected by the University of West Virginia Department of Energy (DOE) sponsored mobile emissions laboratory will be presented. Operational data from Bi-State Development Agency is collected by the University of Missouri and quality control procedures are performed prior to placing the data in the Alternative Fuels Data Center (AFDC). The AFDC is maintained by the National Renewable Energy Laboratory in Golden, Colorado. This effort, which enables transit operators to review a real-world comparison of biodiesel and LSD, has been funded by the National Biodiesel Board with funds provided by the United Soybean Board with national checkoff dollars and the National Renewable Energy Laboratory.

29305 (NREL/CP–200-8098, pp. 902-910) **Conversion of vegetable oils and animal fats into paraffinic cetane enhancers for diesel fuels.** Wong, A. (Arbokem, Inc., Vancouver (Canada)); Feng, Y.; Hogan, E. National Renewable Energy Lab., Golden, CO (United States). [1995]. (CONF-9508104–: 2. meeting on biomass of the Americas, Portland, OR (United States), 21-24 Aug 1995). In *Second biomass conference of the Americas: Energy, environment, agriculture, and industry. Proceedings.* 1741p. Order Number DE95009230. Source: OSTI.

The two principal methods of producing biodiesel fuels are (a) transesterification of vegetable oils and animal fats with a monohydric alcohol, and (b) direct hydrotreating of tree oils, vegetable oils and animal fats. The patented hydrotreating technology is based on the catalytic processing of biomass oils and fats with hydrogen, under elevated temperature and pressure conditions. The typical mix of hydrotreated products is as follows: 5-15% light distillate (naphta), 40-60% middle distillate (cetane), 5-15% heavy distillate and 5-10% burner gas. The naptha fraction may be used as a gasoline supplement. The middle distillate is designed for use as a cetane booster for diesel fuels. Both heavy distillate and light hydrocarbon gases are usable as power boiler fuels. Typically, the cetane enhancer would be admixed with diesel fuel in the range of 5 to 30% by volume. This new diesel blend meets the essential quality characteristics of the basic diesel fuel, for direct use in diesel engines without any modifications. The basic hydrotreatment technology has been evaluated further in the laboratory on degummed soya oil, yellow grease and animal tallow. The preliminary findings suggest that the technology can provide efficient conversion of these materials into cetane enhancers for diesel fuels.

29306 (NREL/CP–200-8098, pp. 921-930) **Producing biodiesel for the "truck in the park" project.** Peterson, C. (Univ. of Idaho, Moscow, ID (United States)); Reece, D.; Thompson, J. National Renewable Energy Lab., Golden, CO (United States). [1995]. (CONF-9508104–: 2. meeting on biomass of the Americas, Portland, OR (United States), 21-24 Aug 1995). In *Second biomass conference of the Americas: Energy, environment, agriculture, and industry. Proceedings.* 1741p. Order Number DE95009230. Source: OSTI.

One of the principal advantages of Biodiesel is its environmental compatibility. Its biodegradability and reduced toxicity make it an ideal candidate fuel for environmentally sensitive areas. Biodiesel has potential as a fuel for equipment operating in or near waterways, sensitive wildlife habitat and other environmentally sensitive areas. The national park system has a mandate to maintain the environment in the areas they supervise. Use of Biodiesel could be one more tool in achieving that goal. This paper is a progress report of a joint project between the University of Idaho, The Montana Department of Natural Resources and Conservation, Wyoming Department of Energy, the PNW and Alaska Regional Bioenergy Program, Chrysler Corporation and the National Park Service to fuel an on-road vehicle for service in Yellowstone National Park. A 5.9L Cummins powered Dodge pickup, supplied by Dodge Truck, is being operated by NPS with fuel produced by the University of Idaho. Tests include regular dynamometer testing, emissions tests, injector coking analysis, oil analysis, detailed operational records and fuel characterization tests according to the ASAE proposed Engineering Practice for Testing of Fuels from Biological Materials, X552.

29307 (NREL/CP–200-8098, pp. 941-950) **Recent progress in biodiesel production and testing at the University of Idaho.** Peterson, C. (Univ. of Idaho, Moscow, ID (United States)); Reece, D.; Thompson, J. National Renewable Energy Lab., Golden, CO (United States). [1995]. (CONF-9508104–: 2. meeting on biomass of the Americas, Portland, OR (United States), 21-24 Aug 1995). In *Second biomass conference of the Americas: Energy, environment, agriculture, and industry. Proceedings.* 1741p. Order Number DE95009230. Source: OSTI.

Biodiesel from vegetable oil and animal fats has been studied at the University of Idaho since 1979. Recent research is directed toward developing and demonstrating commercial technologies. During the last year an on-road vehicle was driven coast-to-coast on Biodiesel for a total of 14,068 km (8742 miles). As part of this on-road testing, the vehicle was tested for emissions on a chassis dynamometer at the LA-MTA emissions test facility in Los Angeles, California. Tests included HC, CO, CO_2, NOx, and PM. The two cycles used in the tests included a modified arterial cycle and the EPA cycle for heavy duty vehicles. Biodiesel research has included producing both methyl and ethyl esters from tallow, canola, soybean oil and rapeseed oil. These eight fuels have been subjected to fuel characterization tests according to the ASAE proposed Engineering Practice, Reporting of Fuel Properties with Testing Diesel Engines and Alternative Fuels Derived from Biological Materials, X552; and short term injector coking tests and performance tests in a turbocharged, DI, CI engine. Two-hundred hour EMA endurance tests in 3-cylinder, DI, CI engines are in progress with each of the fuels.

29308 (NREL/CP–200-8098, pp. 951-960) **On-road testing of rapeseed biodiesel.** Reece, D. (Univ. of Idaho, Moscow, ID (United States)); Peterson, C. National Renewable Energy Lab., Golden, CO (United States). [1995]. (CONF-9508104–: 2. meeting on biomass of the Americas, Portland, OR (United States), 21-24 Aug 1995). In *Second biomass conference of the Americas: Energy, environment, agriculture, and industry. Proceedings.* 1741p. Order Number DE95009230. Source: OSTI.

Two on-road diesel pickups were operated on a mixture of 20 percent Biodiesel and 80 percent for 80,500 km (50,000 miles). One pickup, powered by a 5.9 liter direct injected, turbocharged, and intercooled engine was operated on 20 percent RME and 80 percent diesel. The other pickup, powered by a 7.3 liter, naturally aspirated, precombustion chamber engine, was operated on 20 percent raw rapeseed oil and 80 percent diesel. The engines were unmodified, but modifications were made to the vehicles for the convenience of the test. In order to give maximum vehicle range, fuel mixing was done on-board to extend the driving range to over 4,800 (3,000 miles) between Biodiesel fill ups. Two tanks were added, one for a mixing chamber and one for the Biodiesel fuel tank in the bed of the pickup. Electric fuel pumps supply fuel to the combining chamber for correct proportioning. The Biodiesel fuel tanks were heated through a heat exchanger in the fuel tank with the use of engine coolant. Chassis dynamometer testing, injector coking, engine compression, injector valve opening pressures, and engine oil analyses were performed at a regularly scheduled intervals to monitor the engine performance parameters. RME produced 5 percent less power than D2, 20RME produced 1 percent less than D2. Opacity was reduced 26 percent with RME, 20RME reduced opacity 10 percent, and 20RAW decreased opacity by 11 percent with the snap idle test compared to D2. Emissions tests

with a chassis transient dynamometer at the Los Angeles Metropolitan Authority Emissions Test Facility resulted in a decrease in HC (20 percent), CO (25 percent), NOx (2.6 percent), PM (10.9 percent), and there was no difference in CO_2 with 20RME compared to D2.

29309 (NREL/CP–200-8098, pp. 1190-1199) **Densified fuels from wood waste.** Pickering, W.H. (Lignetics, Inc., La Canada (Canada)). National Renewable Energy Lab., Golden, CO (United States). [1995]. (CONF-9508104–: 2. meeting on biomass of the Americas, Portland, OR (United States), 21-24 Aug 1995). In *Second biomass conference of the Americas: Energy, environment, agriculture, and industry. Proceedings.* 1741p. Order Number DE95009230. Source: OSTI.

Wood compressed to a specific gravity of about 1.2 constitutes an excellent clean burning fuel. "Prestologs" were marketed before 1940, but in the past ten years a much larger and growing market is densified pellet fuel has developed. The market for pellet fuel is about 90% residential, using special pellet burning stoves. Initial sales were almost entirely in the northwest, but sales in other parts of the country are now growing rapidly. Approximately 300,000 stoves are in use. Note that this industry developed from the private sector with little or no support from federal or state governments. Densified fuel is manufactured by drying and compressing sawdust feedstock. Combustion is different than that of normal wood. For example, wood pellets require ample supplies of air. They then burn with a hot flame and very low particulate emissions. Volatile organic compounds are burned almost completely and carbon monoxide can also be kept very low. Stoves burning pellets easily meet EPA standards. This paper discusses technical and economic factors associated with densified fuel and considers the future of the industry.

29310 (NREL/CP–200-8098, pp. 1732-1741) **Development of the Cuban bagasse boiler practice.** Lora, E.S. (Universidad de Oriente, Santiago (Cuba)). National Renewable Energy Lab., Golden, CO (United States). [1995]. (CONF-9508104–: 2. meeting on biomass of the Americas, Portland, OR (United States), 21-24 Aug 1995). In *Second biomass conference of the Americas: Energy, environment, agriculture, and industry. Proceedings.* 1741p. Order Number DE95009230. Source: OSTI.

This paper shows how Cuban bagasse boiler practice began simultaneously with the design of the spreader-stoker boilers RETO and the retrofitting of the horse-shoe furnace German boilers into the RETAL ones. Now the main trend is the retrofitting of the boilers RETO for suspension burning using two systems: the vertical swirl or tangenital fired furnace; and the horizontal swirl furnace. In this paper the main technical characteristics and parameters are presented, as well as the results of the tests with different boilers. Data about temperature gas concentration profiles are different furnaces are also included. The conclusion is that the horizontal swirl furnace is actually the most promising technical solution for the suspension burning of a coarse and polidispersed bagasse like the Cuban one. The generalization of the bagasse suspension burning in horizontal swirl furnace boilers by retrofitting of the existing ones is a present task for the Cuban sugar industry, as well as the design of new high steam parameter boilers using this combustion system.

29311 (NREL/CP–433-7748, pp. 166-174) **Direct sampling of inorganic vapors released during biomass combustion.** Dayton, D.C. (National Renewable Energy Lab., Golden, CO (United States)); Milne, T.A. National Renewable Energy Lab., Golden, CO (United States). Mar 1995. (CONF-9410343–: Applications of free-jet, molecular beam, mass spectrometric sampling conference, Estes Park, CO (United States), 11-14 Oct 1994). In *Applications of free-jet, molecular beam, mass spectrometric sampling: Proceedings.* 305p. Order Number DE95004052. Source: OSTI; NTIS; GPO Dep.

Alkali metal vapors released during biomass combustion cause significant problems in power generating facilities that convert biomass to electricity. Gas phase transport of alkali vapors increases the potential for fouling and slagging heat transfer surfaces in boilers and will cause accelerated erosion and corrosion of turbine blades in future direct biomass-fired facilities. Biomass power is an attractive renewable energy resource; however, alkali deposits that form on surfaces in power generating facilities reduce the efficiency of electricity production. As a result, there is a need to develop methods or define combustion conditions for reducing the transport of alkali metal containing vapors during biomass combustion. One solution to fouling and slagging problems is to develop methods of hot gas cleanup that reduce the amount of alkali vapor to acceptable levels. This requires a detailed understanding of the mechanisms of alkali metal release during biomass combustion and identification of these alkali metal vapors, how these vapors lead to fouling and slagging, and how they may be sequestered. The authors approach is to sample directly the hot gases liberated from the combustion of small biomass samples in a variable temperature quartz tube reactor employing a molecular beam mass spectrometer (MBMS) system to monitor the combustion event. The authors have successfully used this experimental technique to identify alkali metal containing species released during the combustion of selected biomass feedstocks at four different conditions: 1100°C in He/O_2(20%), 800°C in He/O_2(20%), 1100°C in He/O_2(5%), and 1100°C in He/O_2(10%)/Steam(20%). These conditions were chosen to study the effect of temperature, oxygen concentration, and excess steam on alkali metal release and speciation.

29312 (NREL/CP–433-7748, pp. 200-210) **Rapid characterization of lignocellulosic feedstocks for fuels and chemicals: Molecular beam mass spectrometric approach.** Agblevor, F.A. (National Renewable Energy Lab., Golden, CO (United States)); Davis, M.F.; Evans, R.J. National Renewable Energy Lab., Golden, CO (United States). Mar 1995. (CONF-9410343–: Applications of free-jet, molecular beam, mass spectrometric sampling conference, Estes Park, CO (United States), 11-14 Oct 1994). In *Applications of free-jet, molecular beam, mass spectrometric sampling: Proceedings.* 305p. Order Number DE95004052. Source: OSTI; NTIS; GPO Dep.

Rapid characterization of biomass feedstocks has a pivotal role in the development of biomass energy because of the large number of samples that must be analyzed due to the diversity of biomass feedstocks and the significant differences in the chemical and physical properties of these feedstocks. Conventional chemical analysis of biomass feedstocks, although very useful, is time-consuming and not very practical for large scale screening experiments, hence the need for rapid characterization techniques. The molecular beam mass spectrometer and pyrolysis gas chromatography, which can analyze biomass pyrolysis vapors in real time, are unique tools for rapid qualitative and quantitative analyses of biomass feedstocks. Several biomass feedstocks (herbaceous, woody, and agricultural residues) were screened for the effects of storage, season of harvest, geographic location, clonal, and species variation on the pyrolysis products of the feedstocks. For herbaceous species such as sericea lespedeza, the season of harvest had a significant effect on the pyrolysis products. Effects of clonal variation on the composition of hybrid poplar feedstocks was easily discerned with the molecular beam mass spectrometric analysis. The effect of geographic location on the poplar clones pyrolysis products was minimal. However, in the case of switchgrass, varietal influence on the pyrolysis products was minimal, but where the plant was grown had a strong influence on the pyrolysis products of the feedstock. Significant differences because of species variation could also be shown from the pyrolysis products of various biomass feedstocks. The influence of storage time on biomass samples stored outside in the open could also be discerned from the pyrolysis products of the feedstocks. The differences noted in the pyrolysis products of the feedstocks were noted for samples which were significantly degraded during storage either through the action of microflora or weathering.

29313 (SAND–95-8634C) **Laboratory illustrations of the transformations and deposition of inorganic material in biomass boilers.** Baxter, L.L. (Sandia National Labs., Livermore, CA (United States)); Jenkins, B.M. Sandia National Labs., Livermore, CA (United States). [1995]. 11p. Sponsored by USDOE, Washington, DC (United States). DOE Contract AC04-94AL85000. (CONF-9508148–1: Biomass fuels symposium, Chicago, IL (United States), 20-26 Aug 1995). Order Number DE95015993. Source: OSTI; NTIS; GPO Dep.

Boilers fired with certain woody biomass fuels have proven to be a viable, reliable means of generating electrical power. The behavior of the inorganic material in the fuels is one of the greatest challenges to burning the large variety of fuels available to biomass combustors. Unmanageable ash deposits and interactions between ash and bed material cause loss in boiler availability and significant increase in maintenance costs. The problems related to the behavior of inorganic material now exceed all other combustion-related challenges in biomass-fired boilers. This paper reviews the mechanisms of ash deposit formation, the relationship between fuel properties and ash deposit properties, and a series of laboratory tests in Sandia's Multifuel Combustor designed to illustrate how fuel type, boiler design, and boiler operating conditions impact ash deposit properties.

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Refer also to citation(s) 29194, 29196, 29197, 29204, 29208, 29210, 29221, 29236, 29237, 29238, 29239, 29240, 29241, 29243, 29244, 29245, 29250, 29274, 29275, 29276, 29277, 29278, 29287, 29290, 29298, 29304, 29341, 29362, 29441, 29884, 29957

29314 (NREL/CP–200-8098, pp. 323-332) **Carbohydrate biofuels II: The need and the potential for rootfuel in the Navajo Nation.** Shultz, E.B. (Enable International, Wheaton, IL (United States)); Jr.; Bragg, W.G.; Whittier, J. National Renewable Energy Lab., Golden, CO (United States). [1995]. (CONF-9508104–: 2. meeting on biomass of the Americas, Portland, OR (United States), 21-24 Aug 1995). In *Second biomass conference of the Americas: Energy, environment, agriculture, and industry. Proceedings.* 1741p. Order Number DE95009230. Source: OSTI.

Over 80% of rural Navajos and about two-thirds of all Navajos use scarce woodfuel and low-grade coal for home heating half the year, with coal used mainly as a nighttime adjunct. Serious health problems arise because stoves are old and leak smoke and carbon monoxide. The impacts are gender-biased to women and small children. Respiratory disease is a major cause of Navajo mortality and unusually high admissions to Navajo Indian Health Service hospitals. A 1990 study at a Navajo hospital showed that Navajo children under two years of age from homes with woodstoves are nearly five times more likely to contract acute lower respiratory tract infections than children from homes with no stove. Correctives include improved stoves and fuels. Our previous studies on clean-burning starchy/cellulosic "rootfuels" in Latin America, Africa, and Asia are applicable. We discuss our preliminary work on the Navajo reservation, the current status of household stoves and stovefuels, the health impacts of woodsmoke and coalsmoke from old, faulty stoves, the conditions for growing rootfuel on the reservation, and policy and strategy for coping with the problem.

29315 (NREL/CP–200-8098, pp. 515-522) **Rural energy development initiative.** Bradshaw, D.T. (Tennessee Valley Authority, Chattanooga, TN (United States)). National Renewable Energy Lab., Golden, CO (United States). [1995]. (CONF-9508104–: 2. meeting on biomass of the Americas. Portland, OR (United States), 21-24 Aug 1995). In *Second biomass conference of the Americas: Energy, environment, agriculture, and industry. Proceedings.* 1741p. Order Number DE95009230. Source: OSTI.

The Utility Biomass Energy Commercialization Association is an association of 22 electric utilities, power producers, equipment developers and related biomass organizations that support the development of economical sustainable biomass resources and economically competitive biomass energy conversion technologies for the benefit of electric utilities, power producers, their customers and society. The Rural Energy Development Initiative, REDI, is UBECA's recommendation for a national program for biomass energy, which is outlined here. Focussed on farm-grown, closed-loop biomass systems, REDI is divided into three concurrent tracks, each a key element of commercialization-sustainable resources, conversion technologies, and economic development. REDI examines the benefits of biomass energy and recommends next steps for all of its stakeholders. The primary obstacle to commercialization is the lack of information transfer and alliance-building at every level-between federal agencies, between state agencies, and between power producers and potential feedstock producers.

29316 (NREL/CP–200-8098, pp. 523-532) **Creating a biopower agenda through grassroots organizing.** Hauter, W. (Union of Concerned Scientists, Washington, DC (United States)). National Renewable Energy Lab., Golden, CO (United States). [1995]. (CONF-9508104–: 2. meeting on biomass of the Americas, Portland, OR (United States), 21-24 Aug 1995). In *Second biomass conference of the Americas: Energy, environment, agriculture, and industry. Proceedings.* 1741p. Order Number DE95009230. Source: OSTI.

Biomass electricity provides both opportunities for strengthening the rural economy and advancing environmental goals. However, while large scale biomass development can be done in a manner that both furthers economic development and helps prevent environmental degradation, its commercialization requires a complex coordination of activities between utilities and farmers. Inherent problems exist in creating parallel development of a resource base and technological advancements. In fact, an understanding of the anthropology of biopower is necessary in order to advance it on a large scale. The Union of Concerned Scientists (UCS) published a report on renewable electricity, released in March 1992, that has been used as a foundation for state-based work promoting renewables. In several Midwestern states, such as Nebraska, Minnesota, and Wisconsin, we have used classic grassroots organizing skills to educate the public and key constituencies about the benefits of biomass. Besides working directly with utilities to promote biomass development, we also have a legislative agenda that helps create a climate favorable to biopower. This paper will focus on the grassroots aspect of our campaigns. It will also include an overview of some anthropological work that the author has done in communities with farmers. The main tool for this has been focus groups. We have found that people can be organized around biomass issues and that a grassroots base furthers biomass development.

29317 (NREL/CP–200-8098, pp. 702-710) **Recent utility efforts to develop advanced gasification biomass power generation facilities.** Donovan, C.T. (C.T. Donovan Associates, Inc., Burlington, VT (United States)); Fehrs, J.E. National Renewable Energy Lab., Golden, CO (United States). [1995]. (CONF-9508104–: 2. meeting on biomass of the Americas, Portland, OR (United States), 21-24 Aug 1995). In *Second biomass conference of the Americas: Energy, environment, agriculture, and industry. Proceedings.* 1741p. Order Number DE95009230. Source: OSTI.

This paper provides a status report on recent utility efforts to evaluate cost-effective opportunities for developing advanced gasification biomass power generation facilities and, in some cases, to actually begin developing the facilities. An overview is provided of national estimates of the potential for producing electricity from various biomass feedstocks. Major manufacturers of advanced gasification biomass power generation technologies are described. Major biomass power generation projects underway by utilities in the U.S. are described. Significant issues affecting further commercialization of biomass gasification facilities are discussed and strategies for addressing the barriers are suggested.

29318 (NREL/CP–200-8098, pp. 1262-1271) **The economics of biomass and biomass-derived energy and fuels.** Bluhm, G.C. (USDA, Washington, DC (United States)); Conway, R.K.; Roningen, V.O. National Renewable Energy Lab., Golden, CO (United States). [1995]. (CONF-9508104–: 2. meeting on biomass of the Americas, Portland, OR (United States), 21-24 Aug 1995). In *Second biomass conference of the Americas: Energy, environment, agriculture, and industry. Proceedings.* 1741p. Order Number DE95009230. Source: OSTI.

Biomass crops (e.g. grasses, wood) could become important feedstocks for the production of power, liquid fuels, chemicals, and other industrial products. With successful research programs that boost biomass crop yields and develop competitive power and chemical conversion technologies, these crops might compete with fossil fuels for a broad range of uses. The development of a biomass industry could bring significant environmental benefits while providing new income opportunities for farmers and processing jobs in rural communities. Economic trends, technological developments, the policy environment, and demonstration efforts at the site-specific local level will determine whether the opportunities for a biomass industry are realized. The economic competitiveness of

crops as inputs to energy and chemical production has improved, relative to fossil fuels. Projections of crop and energy prices suggest that these economic trends are likely to continue. many economic factors can influence the future of biomass crops, including changes in world energy prices, increased environmental costs associated with fossil fuel use, major advances in technology that reduce the cost of biomass production and processing, and the development of profitable product mixes from biomass processing. The potential of biomass as a fuel for electricity generation illustrates these factors. With current technology, biomass based-electricity generation is a niche market in situations where electricity is expensive and fuel is cheap or incurs a disposal cost, e.g. waste wood, sawdust, etc. Some utilities are now interested in co-firing wood with coal because of environmental reasons, provided wood fuel costs are low enough. If dedicated biomass production and power systems demonstrate themselves to be workable, a larger competitive biomass-based power industry could develop.

29319 (NREL/CP–200-8098, pp. 1272-1290) **Cost versus scale for advanced plantation-based biomass energy systems in the U.S.A. and Brazil.** Marrison, C.I. (Princeton Univ., NJ (United States)); Larson, E.D. National Renewable Energy Lab., Golden, CO (United States). [1995]. (CONF-9508104–: 2. meeting on biomass of the Americas, Portland, OR (United States), 21-24 Aug 1995). In *Second biomass conference of the Americas: Energy, environment, agriculture, and industry. Proceedings.* 1741p. Order Number DE95009230. Source: OSTI.

A unique feature of biomass energy systems is that the feedstock must be gathered from a wide area around the energy production facility. For a small-scale facility, transport costs will be relatively low, but capital cost per unit of output will be high. For a large-scale facility, transport costs will be high, but capital costs will be relatively low. At some intermediate scale, the total cost of energy should reach a minimum. This paper examines the effects of scale n the prospective costs of electricity and alcohol fuels from plantation-grown switchgrass in the North Central and Southeast regions of the USA and from eucalyptus in Bahia state, Brazil. Biomass cost-supply curves for the year 2000 and 2020 are developed for the USA sites using estimates by the Oak Ridge National Laboratory for switchgrass yields and costs. A geographic information system (GIS) is used to analyze soil quality (and yield) distributions and road transport distances. A simplified approach is outlined for developing biomass supply curves to avoid data-intensive, time-consuming GIS analysis. The approach is applied for the analysis of data collected at the Brazil site. Conversion technologies considered include one commercial electric generating technology–the steam ranking cycle–and one nearing commercial readiness–the gasifier/gas turbine combined cycle. Two alcohol fuels are considered: methanol via thermochemical gasification and ethanol via enzymatic hydrolysis. Both of these processes could be commercially ready early in the next century. Estimates of installed capital costs for all of these conversion systems are based on published sources. In all cases, the minimum cost of electricity (COE_{min}) or alcohol (COA_{min}) is reached at relatively large plant capacity, because up to that point the rate of decrease in unit capital costs is more rapid than the rate of increase in biomass transportation costs.

29320 (NREL/CP–200-8098, pp. 1291-1301) **Comparative evaluation of fuel costs from energy crops.** Hughes, E.E. (Electric Power Research Institute, Palo Alto, CA (United States)); Wiltsee, G.A. Jr. National Renewable Energy Lab., Golden, CO (United States). [1995]. (CONF-9508104–: 2. meeting on biomass of the Americas, Portland, OR (United States), 21-24 Aug 1995). In *Second biomass conference of the Americas: Energy, environment, agriculture, and industry. Proceedings.* 1741p. Order Number DE95009230. Source: OSTI.

Experience with establishment, cultivation, and harvesting of biomass crops is limited to the work of forest products companies and a few small government-funded research trials of energy crops. This experience is not yet sufficient to allow renewable energy project planners to estimate the cost of fuel from energy crops with confidence. This paper summarizes, compares, and evaluates the results of several recent engineering-type studies that address the cost of farm-grown biomass fuel, with emphasis on short rotation woody crops (SRWC). These studies–by such organizations as Oak Ridge national Laboratory, University of Minnesota (Natural Resources Research Institute - Duluth), University of California (Davis), Pennsylvania State University, State University of New York (Syracuse), and the Electric Power Research Institute – identify the key cost elements, the likely ranges of those elements, and the conditions, government policies, and technical developments that will help drive down the cost of biomass fuel to a competitive level. Fuel from energy-dedicated SRWC using fast-growing clonal varieties of trees is projected to cost as little as $1/MBtu and as much as $4/MBtu, depending on conditions. Key cost elements include (1) "stumpage" price (establishment and cultivation costs, i.e., pre-harvest costs), estimated to range from $18 to $41/dry ton (dt); (2) harvest and handling cost, estimated to range from $2 to $19/dt; and (3) transport cost, estimated at about $8.50/dt for a nominal 40-mile haul. (The higher heating value of wood is about 17 MBtu/dt.) Conditions necessary to achieve the low end of the cost range, and thus make biomass a competitive fuel, include either (1) an agricultural subsidy such as the Conservation Reserve Program; and/or (2) very high yields of biomass; and (3) development of an agricultural-type harvesting machine to place trees directly on transport vans without separate skidding and loading operations.

29321 (NREL/CP–200-8098, pp. 1302-1308) **In the aftermath of PURPA: The future of the biomass energy industry in Maine.** Adams, S.J. (Marine State Planning Office, Augusta, ME (United States)); Connors, J.F. National Renewable Energy Lab., Golden, CO (United States). [1995]. (CONF-9508104–: 2. meeting on biomass of the Americas, Portland, OR (United States), 21-24 Aug 1995). In *Second biomass conference of the Americas: Energy, environment, agriculture, and industry. Proceedings.* 1741p. Order Number DE95009230. Source: OSTI.

During the 1980's the biomass power industry in Maine grew to nearly 500 MW of installed capacity in 21 cogeneration and stand alone plants. By 1992 these plants consumed four million tons of woody fuels annually, while providing 25% of the states' electricity supply. Moreover, this new industry supported over 2500 jobs throughout rural Maine, generated substantial local property taxes and provided a critically need management option for forest management and mill waste disposal. All of this capacity was developed by non-utility generators as Qualifying Facilities (QF) under PURPA rules. Most power contracts were fixed price, must take agreements guided by avoided cost calculations that assumed high future costs for energy alternatives. Circumstances have changed. Historically low oil prices, economic recession, and rising electricity rates have made biomass fueled power plants some of the most expensive sources of electricity on the power grid. Utilities are responding to rising rates, to public and political pressure to control costs and lower rates by seeking to renegotiate or buy out power contracts and closing biomass plants. While there are strong demands to control electricity costs, there are equally strong concerns about losing the benefits that accrue from the use of indigenous renewable resources. This article evaluates the actions of Maine utilities, independent power producers, the Maine Public Utilities Commission, and the Main Legislature related to PURPA contracts and their likely effects on the future of the biomass power industry in Maine. In particular, we will describe Maine's new Electric Rate Stabilization Program and subsequent efforts of the Executive Branch to mediate a compromise solution in one case of a utility buy out of a biomass power plant.

29322 (NREL/CP–200-8098, pp. 1314-1323) **The economics of biomass production in the United States.** Graham, R.L. (Oak Ridge National Lab., TN (United States)); Walsh, M.E.; Lichtenberg, E. National Renewable Energy Lab., Golden, CO (United States). [1995]. DOE Contract AC05-84OR21400. (CONF-9508104–: 2. meeting on biomass of the Americas, Portland, OR (United States), 21-24 Aug 1995). In *Second biomass conference of the Americas: Energy, environment, agriculture, and industry. Proceedings.* 1741p. Order Number DE95009230. Source: OSTI.

Biomass crops (e.g. poplar, willow, switchgrass) could become important feedstocks for power, liquid fuel, and chemical production. With successful research programs that boost crop yields and develop appropriate power and chemical conversion technologies, biomass might compete with fossil fuels for a broad range of uses.

Compared to fossil fuels, biomass feedstocks can offer significant environmental benefits. For example, biomass crops do not add greenhouse gases to the atmosphere during their life cycle. This paper presents estimates of the potential production of biomass in the United States under a range of assumptions. Estimates of potential biomass crop yields and production costs from the Department of Energy's (DOE) Oak Ridge National Laboratories (ORNL) are combined with measures of land rents from USDA's Conservation Reserve Program (CRP), to estimate a competitive supply of biomass wood and grass crops. Estimates are made for one potential biomass use--electric power production--where future costs of electricity production from competing fossil fuels set the demand price. The paper outlines the methodology used and limitations of the analysis. Currently, biomass-based electricity generation is a niche market where electricity is expensive and fuel is cheap or incurs a disposal cost, e.g. waste wood, sawdust, etc. However, if biomass production and usage systems demonstrate themselves to be workable at DOE's projected costs,biomasss crops might become competitive for electricity production and other uses. Increases in fossil fuel prices, more rapid advances in gasification-gas turbine power generation technology, or rapid market development for biomass-based co-products such as pulp wood or chemicals could accelerate the production of biomass for electricity generation. Policies that discourage greenhouse gas emissions or encourage biomass production on idle land could also make biomass feedstocks more competitive with fossil fuels for a range of uses.

29323 (NREL/CP–200-8098, pp. 1334-1344) **Guidelines for obtaining favorable project financing, federal tax incentives, and various state incentives to fund biomass energy development.** Lubin, M. (Lubin Financial, San Diego, CA (United States)); Sanderson, G.A. National Renewable Energy Lab., Golden, CO (United States). [1995]. (CONF-9508104–: 2. meeting on biomass of the Americas, Portland, OR (United States), 21-24 Aug 1995). In *Second biomass conference of the Americas: Energy, environment, agriculture, and industry. Proceedings.* 1741p. Order Number DE95009230. Source: OSTI.

This paper outlines methods for funding biomass project development. This paper discusses sources of project financing, identifies potential problems associated with financing biomass projects, and provides a brief summary of typical lender requirements. In addition, this paper identifies potential tax incentives and other benefits available from federal and state governments to promote biomass energy.

29324 (NREL/CP–200-8098, pp. 1345-1354) **Private funding of a biomass power project: Williams Lake case history.** Baker, B.Z. (Tondu Energy, Inc., Houston, TX (United States)). National Renewable Energy Lab., Golden, CO (United States). [1995]. (CONF-9508104–: 2. meeting on biomass of the Americas, Portland, OR (United States), 21-24 Aug 1995). In *Second biomass conference of the Americas: Energy, environment, agriculture, and industry. Proceedings.* 1741p. Order Number DE95009230. Source: OSTI.

Private funding for a biomass power project is available if the project is properly structured, the cash flow can be forecasted with a high degree of confidence, the project provides long-term benefits and the risks have been mitigated or allocated among the participants. The Williams Lake Project, a 60 MW wood waste fueled power plant in British Columbia, has all of these elements. Twenty two year fixed rate financing was provided from a group of Canadian life insurance companies and pension funds without any type of government guarantee. The syndicate provided 90% of the $150 million (Cdn.) cost and 10% was financed by equity. The original partners of the project were Tondu Energy Systems, a developer of independent power projects and owner of a 54 MW coal fired cogeneration facility in Michigan, a subsidiary of the Washington Water Power Company who owns and operates a 50 MW wood waste project in Washington and a subsidiary of BC gas who has extensive knowledge and experience of doing business in British Columbia. A 25 year Power Purchase Agreement was executed with B.C. Hydro which provided for the payment of electricity. The project provided B.C. Hydro with long-term, reliable electricity. Fuel for the project is provided by local sawmills who were able to close down their beehive burners. This significantly reduced the particulate emissions in the Williams Lake area solving a severe, long standing air pollution problem. Long term fuel supply agreements were executed with the local sawmills which provided fuel at no acquisition cost for 25 years. Supplemental wood waste supply agreements were also executed, further reducing any risk of fuel supply. Construction risk was minimized because of the Turnkey Construction Agreement which provided performance guarantees and liquidating damages. Also, construction management was provided by the owner to ensure the plant was built in accordance with the design specifications.

29325 (NREL/CP–200-8098, pp. 1355-1362) **The role of the World Bank in financing biomass energy projects.** Terrado, E.N. (World Bank, Washington, DC (United States)). National Renewable Energy Lab., Golden, CO (United States). [1995]. (CONF-9508104–: 2. meeting on biomass of the Americas, Portland, OR (United States), 21-24 Aug 1995). In *Second biomass conference of the Americas: Energy, environment, agriculture, and industry. Proceedings.* 1741p. Order Number DE95009230. Source: OSTI.

The World Bank's financing of biomass energy projects has been principally in relation to the excessive use of biomass for fuel in developing countries and the measures that are needed to curb demand and reduce its adverse environmental impacts. With respect to projects for the conversion of biomass into liquid and gaseous fuels and electricity, the Bank's role has been more limited. The major reasons for this limited role include the still unfavorable economics of many of the technologies in comparison to the current cost of conventional fuels. the small size and dispersed nature of some of already economic biomass projects and the general lack of information in the Bank on the technology status and economics of the more modern biomass energy applications. Nevertheless, in the early 80s, the Bank financed one of the largest and most important biomass projects in developing countries, the Brazil Alcohol and Biomass Energy Development Project. During this period, it also conducted various preinvestment studies on biomass gasification, bagasse cogeneration in sugar mills and other technologies for the generation of power from biomass resources. None of these studies led to Bank lending to governments, but a number were financed by the private sector directly or through the International Finance Corporation (IFC), the arm of the Bank Group that deals with the private sector. With the current worldwide concern for global warming and the creation of the Global Environment Facility (GEF), the World Bank group is revisiting its involvement in the promotion of environmentally benign energy generation technologies. It recently launched a new program called the "Solar Initiative" that seeks to increase Bank investments in direct solar, wind and biomass energy applications in developing countries. The most recent Bank activity in biomass energy is financing for a prototype 30 MW biomass gasification project in Brazil.

29326 (NREL/CP–200-8098, pp. 1363-1371) **Tax issues and incentives for biomass products.** Martin, K. (Chadbourne & Parke, Washington, DC (United States)). National Renewable Energy Lab., Golden, CO (United States). [1995]. (CONF-9508104–: 2. meeting on biomass of the Americas, Portland, OR (United States), 21-24 Aug 1995). In *Second biomass conference of the Americas: Energy, environment, agriculture, and industry. Proceedings.* 1741p. Order Number DE95009230. Source: OSTI.

The more sophisticated developers of biomass projects figure out ways to structure their projects to take advantage of tax subsidies. The federal government offers at least eight tax subsidies for biomass. This is rather like building a house. One tries to design the house to build in as many of these features as possible. The more tax benefits that can be built into the ownership structure for a project, the less the project will cost at the end of the day.

29327 (NREL/CP–200-8098, pp. 1372-1381) **Strategies for the development of biomass in industrialized countries.** Silguy, C. de (French Agency for the Environmental and Enrgy Management Science Division, Paris (France)). National Renewable Energy Lab., Golden, CO (United States). [1995]. (CONF-9508104–: 2. meeting on biomass of the Americas, Portland, OR (United States), 21-24 Aug 1995). In *Second biomass conference of the Americas: Energy, environment, agriculture, and industry. Proceedings.* 1741p. Order Number DE95009230. Source: OSTI.

Ademe is currently conducting a study commissioned by the European Commission (DG XII) on "Strategies for the Development of Biomass in Industrialized Countries." This study surveys twelve countries. As the study is not yet completed, this report presents results from six countries. Energy, agricultural, industrial and environmental policy all have an impact on strategies in biomass production and on the priorities of research-development programs. These policies vary from country to country, but certain common trends can be observed. At present biomass is produced primarily for heating use. In the future this raw material could become a prime resource for the production of electricity and vehicle fuels. Each country gives priority to one or two forms of production. The principal strategic goals are the following: attain cost-competitiveness in various market segments; occupy specialized and niche markets as feasible; structure markets and production processes when acceptable cost levels are reached; and prepare future activity via R&D programs.

29328 (NREL/CP–200-8098, pp. 1382-1389) **The California biomass power industry in the era of restructuring.** Morris, G. (Future Resource Associates, Inc., Berkeley, CA (United States)). National Renewable Energy Lab., Golden, CO (United States). [1995]. (CONF-9508104–: 2. meeting on biomass of the Americas, Portland, OR (United States), 21-24 Aug 1995). In *Second biomass conference of the Americas: Energy, environment, agriculture, and industry. Proceedings.* 1741p. Order Number DE95009230. Source: OSTI.

During the 1980s California led the world in the development of the biomass power industry. By 1995 the industry had overcome a series of hurdles and achieved a comfortable operating equilibrium. Nevertheless, menacing clouds on the horizon threaten to shut down most of the industry by the year 2000 unless solutions are found. Should the worst happen, it would represent an unmitigated disaster for the long-term development of the biomass energy potential of the U.S., the Americas, and the world. Most of the biomass facilities in California operate under power sales agreements in which energy prices decrease significantly after ten years of operations. Furthermore, the electric utility reconstructuring process that has begun in California threatens to place additional downward pressure on the price that biomass generators earn for their product (electricity). Biomass power generation simply cannot compete in a deregulated world of 21/2 ¢/kWh power purchase prices unless a mechanism is established to credit it for its environmental benefits, particularly those in the areas of solid waste disposal and greenhouse gas reduction. This paper describes the current state of the industry, how it has arrived where it is, and efforts being pursued to secure its future.

29329 (NREL/CP–200-8098, pp. 1390-1396) **A premium price electricity market for the emerging biomass industry in the UK.** Kettle, R. (UK Department of Trade and Industry, London (United Kingdom)). National Renewable Energy Lab., Golden, CO (United States). [1995]. (CONF-9508104–: 2. meeting on biomass of the Americas, Portland, OR (United States), 21-24 Aug 1995). In *Second biomass conference of the Americas: Energy, environment, agriculture, and industry. Proceedings.* 1741p. Order Number DE95009230. Source: OSTI.

The Non-Fossil Fuel Obligation (NFFO) is the means by which the UK Government creates an initial market for renewable sources of electricity. For the first time the third round of the competition for NFFO contracts included a band for 'energy crops and agricultural and forestry wastes'. The NFFO Order which obliges the Regional Electricity Companies (RECs) in England and Wales to contract for a specified electricity generating capacity from renewable resources was made in December 1994. It required 19.06 MW of wood gasification capacity and 103.81 MW from other energy crops and agricultural and forestry wastes. The purpose of these Orders is to create an initial market so that in the not too distant future the most promising renewables can compete without financial support. This paper describes how these projects are expected to contribute to this policy. It also considers how the policy objective of convergence under successive Orders between the price paid under the NFFO and the market price for electricity might be accomplished.

29330 (NREL/CP–200-8098, pp. 1418-1427) **Biomass electricity: Long-run economic prospects and climate policy implications.** Turnure, J.T. (EPA, Washington, DC (United States)); Winnett, S.; Shackleton, R. National Renewable Energy Lab., Golden, CO (United States). [1995]. (CONF-9508104–: 2. meeting on biomass of the Americas, Portland, OR (United States), 21-24 Aug 1995). In *Second biomass conference of the Americas: Energy, environment, agriculture, and industry. Proceedings.* 1741p. Order Number DE95009230. Source: OSTI.

This paper reports an integrated assessment of the long-run domestic prospects for the use of commercial bioenergy crops in electricity generation, using a unique set of optimization models of the agriculture, forestry and electric utility sectors. We perform a series of scenarios based on the range of expert opinion regarding future economic and technological developments. In the most optimistic scenario, a model research and development program carried out over the next decade could lead to a significant competitive biomass market in the United States. This scenario assumes that energy crop yields can be improved fairly dramatically, that biomass-fired electricity generation technologies can be engineered to compete favorably against fossil technologies, and that fossil fuel prices rise modestly over the next twenty-five years. Given these assumptions, we estimate that biomass grown on some 12 million hectares (40 million acres) of land would account for some 10% of all fuel used in electricity generation, displacing about 90 million metric tons of carbon emissions annually by 2025. A domestic biomass industry of this magnitude could provide roughly 20% of the cumulative reductions needed to stabilize emissions at 1990 levels over the entire period 2000-2025. On the other hand, if more pessimistic assumptions materialize-if yield improvements are modest, if biomass electricity generation technologies do not compete against similar fossil fuel technologies, and if coal prices continue to decline at even a fraction of the pace that they have over the past decade-then biomass would require a subsidy nearly equivalent to the cost of the fuel to achieve the same market penetration as in the optimistic scenario. Our own best estimate is closer to the pessimistic scenario than the optimistic one, because we expect that productivity improvements will continue to lower real coal prices and because scale economies will favor large coal plants over smaller biomass plants.

29331 (NREL/CP–200-8098, pp. 1428-1436) **Evaluating the economic costs, benefits and tradeoffs of dedicated biomass energy systems: The importance of scale.** Graham, R.L. (Oak Ridge National Lab., TN (United States)); Walsh, M.E. National Renewable Energy Lab., Golden, CO (United States). [1995]. DOE Contract AC05-84OR21400. (CONF-9508104–: 2. meeting on biomass of the Americas, Portland, OR (United States), 21-24 Aug 1995). In *Second biomass conference of the Americas: Energy, environment, agriculture, and industry. Proceedings.* 1741p. Order Number DE95009230. Source: OSTI.

The economic and environmental costs, benefits and tradeoffs of bioenergy from dedicated biomass energy systems must be addressed in the context of the scale of interest. At different scales there are different economic and environmental features and processes to consider. The depth of our understanding of the processes and features that influence the potential of energy crops also varies with scale as do the quality and kinds of data that are needed and available. Finally, the appropriate models to use for prediction economic and environmental impacts change with the scale of the questions. This paper explores these issues at three scales - the individual firm, the community, and the nation.

29332 (NREL/CP–200-8098, pp. 1456-1467) **Sustainable biomass utilization.** Harris, W.L. (USDA, Washington, DC (United States)); Rosen, H.N. National Renewable Energy Lab., Golden, CO (United States). [1995]. (CONF-9508104–: 2. meeting on biomass of the Americas, Portland, OR (United States), 21-24 Aug 1995). In *Second biomass conference of the Americas: Energy, environment, agriculture, and industry. Proceedings.* 1741p. Order Number DE95009230. Source: OSTI.

Interest in utilization of biomass for energy and industrial products is worldwide. This interest is being driven by a variety of concerns that include the rate of increase in fossil fuel consumption with associated greenhouse gas emissions, in-country energy security, and enhancement of rural economics. Interwoven in the discussions of enhancing biomass utilization is sustainability. The

concept and understanding of sustainability are explored and discussed. The barriers and/or challenges that must be addressed and the viable solutions developed for a substantial increase in biomass utilization are presented.

29333 (NREL/CP–200-8098, pp. 1468-1476) **The economic impact of wood energy in the Northeastern United States.** High, C.J. (Resource Systems Group, Inc., White River Junction, VT (United States)). National Renewable Energy Lab., Golden, CO (United States). [1995]. (CONF-9508104–: 2. meeting on biomass of the Americas, Portland, OR (United States), 21-24 Aug 1995). In *Second biomass conference of the Americas: Energy, environment, agriculture, and industry. Proceedings.* 1741p. Order Number DE95009230. Source: OSTI.

This paper provides an assessment of the economic impacts, in terms of direct and indirect employment, income and tax payments, generated by the industrial and residential use of wood for energy in the eleven Northeastern States. The assessment is based on state level data collection and analysis of wood energy use, combined with state level economic data. Indirect and induced economic impacts, the economic impacts of cost savings and the displacements of conventional fuels, are assessed using the IMPLAN input/output model of the state and regional economies. The total use of wood fuel in the northeastern states in 1992 was estimated to be approximately 28,000,000 tons (U.S. tons at 50% moisture), made up of 16,000,000 tons used in the residential sector and 12,000,000 tons in the industrial sector. The net economic impact of wood energy was 34,000 jobs and $1.8 billion in income for the region in 1992. The residential sector generated $1.17 billion and the industrial sector $667,000,000 in net regional income. The residential sector produced 23,000 jobs, while the industrial sector produced 11,000 jobs. Wood energy use eliminates the need for approximately 4 million megawatt hours of electricity are also saved. Wood energy generated activities pay approximately $46,000,000 in state and local taxes and $355,000,000 in federal taxes in the region.

29334 (NREL/CP–200-8098, pp. 1494-1503) **Commercialization of biomass ethanol: Plant siting studies.** Mielenz, J. (National Renewable Energy Lab., Golden, CO (United States)); Parson, F.; Koepping, D. National Renewable Energy Lab., Golden, CO (United States). [1995]. (CONF-9508104–: 2. meeting on biomass of the Americas, Portland, OR (United States), 21-24 Aug 1995). In *Second biomass conference of the Americas: Energy, environment, agriculture, and industry. Proceedings.* 1741p. Order Number DE95009230. Source: OSTI.

With the recent commissioning of the National Renewable Energy Laboratory's (NREL) process development unit, through the support of the U.S. Department of Energy (DOE) Biofuels Program, the technology for enzymatically converting lignocellulosic biomass to fuel ethanol has reached the pilot scale. Construction will begin soon on precommercial scale engineering demonstration units (EDUs), which will probably be built at or near proposed commercial plant sites, to demonstrate this technology at selected biomass-rich locations in the United States. Proper site selection can be critical to these units' long-term profitability, so DOE and NREL have begun a program to help industrial partners build sound business plans that include detailed siting studies. These studies examine biomass availability and cost projections, delineate site requirements and identify qualifying sites, examine environmental and community impacts, and provide detailed pro forma financial evaluations and projections. The DOE/NREL ethanol project currently support eight such plans, which help industry identify economically viable commercial opportunities for biomass ethanol.

29335 (NREL/CP–200-8098, pp. 1514-1523) **An assessment of northwest regions using the Utility Tracking System.** Harrison, I.S. (DynCorp Environmental, Alexandria, VA (United States)); Roberts, P.A.; Tanner, S.L. National Renewable Energy Lab., Golden, CO (United States). [1995]. (CONF-9508104–: 2. meeting on biomass of the Americas, Portland, OR (United States), 21-24 Aug 1995). In *Second biomass conference of the Americas: Energy, environment, agriculture, and industry. Proceedings.* 1741p. Order Number DE95009230. Source: OSTI.

The electric utility industry is currently undergoing major changes. These changes facilitate the need to have a better understanding of the changing utility environment. This assessment will focus on utility data contained within the Utility Tracking System (UTS). Specifically, this assessment will characterize a portion of the northwest electric utility information through use of the UTS. The UTS data includes: utility planning approaches and procedures; federal and state legislation and regulation; financial and operating information; non-utility purchases; research and development expenditures. A major focus of the study will be to assess a wide range of electricity options with particular emphasis renewable technologies including biomass. DynCorp EENSP performed an examination of utility planning approaches and procedures for the National Renewable Energy Laboratory under contract to the Department of Energy Office of Utility Technologies. This research also included characterization of utility stakeholders; and analysis of regulatory and legislative precedents for 86 utilities with representation in each state and the District of Columbia. The resulting information was incorporated into a Utility Tracking System database which includes data on load forecasting, demand-side management analysis, capacity expansion planning, production cost analysis, transmission and distribution planning, and other issues addressed by the utilities in their integrated resource plans, in addition to detailed information on utility, federal and state resource planning processes, procedures, and requirements. The UTS is a prototype database, and is used to facilitate quick and accurate investigations of a very large number of variables pertinent to electric utilities.

29336 (NREL/CP–200-8098, pp. 1534-1546) **Commercialization of willow bioenergy - a dedicated feedstock supply system.** White, E.H. (State Univ. of New York College, Syracuse, NY (United States)); Abrahamson, L.P.; Robison, D.J. National Renewable Energy Lab., Golden, CO (United States). [1995]. (CONF-9508104–: 2. meeting on biomass of the Americas, Portland, OR (United States), 21-24 Aug 1995). In *Second biomass conference of the Americas: Energy, environment, agriculture, and industry. Proceedings.* 1741p. Order Number DE95009230. Source: OSTI.

Willow hybrids grown as a Dedicated Feedstock Supply System (DFSS) have been analyzed and found to be a feasibile means of augmenting current coal and natural gas resources for power generation. This study focused on the technology and infrastructure required to grow willow DFSS and integrate it with four existing pulverized coal electric generation facilities in central and western New York. The study found that both utilities and growers can forge a long-term business relationship that offers fuel diversity, fuel cost competitiveness and environmental benefits for the utility partners while reinvigorating central and western New York business in the agricultural sector. Growers can bring idle land and land being farmed at a loss back into profitable production while reducing environmental impacts associated with more traditional row crops. The Consortium is gearing up to put in place the growers contracts and the acreage necessary to take the first steps to prove and develop a major new business opportunity for rural New York.

29337 (NREL/CP–200-8098, pp. 1547-1556) **The feasibility of sustainable biomass energy production in Kansas.** Johnson, D.A. (Pinnacle Technology, Lawrence, KS (United States)); Maclean, W.D.; Asad, M. National Renewable Energy Lab., Golden, CO (United States). [1995]. (CONF-9508104–: 2. meeting on biomass of the Americas, Portland, OR (United States), 21-24 Aug 1995). In *Second biomass conference of the Americas: Energy, environment, agriculture, and industry. Proceedings.* 1741p. Order Number DE95009230. Source: OSTI.

In January 1994, the Department of Energy announced that 12 projects were chosen to study the feasibility of integrated production-conversion technologies for energy from biomass systems. The team represented by the authors was chosen for one project reflecting the Midwest region of the United States. The project site was Holton, Kansas (30 miles north of Topeka), a rural community which generates its own peaking power. This report is a summary of the technical and economic feasibility of producing three to five MW of baseload power using dedicated biomass feedstocks as the fuel supply and a fast pyrolysis system as the

conversion process. Big bluestem/indiangrass and switchgrass had the best energy feasibility for the system. The conversion facility was sized for 100 bone dry tons of feedstock per day and was estimated to cost just over $4.5 million. The environmental, market and socio-economic impacts of the dedicated feedstocks and conversion study were examined. Based on all the data, the economic analysis predicted the facility would break-even at approximately $0.07 per kWh using a very aggressive best-case scenario. Since much of the Midwest has low baseload electricity prices ($0.02-0.03), biomass power based on a dedicated feedstock supply system does not appear to be an attractive option at the current time. There may be specific instances where biomass power will be an option-especially for peaking power or from waste feedstocks that are free, or have a tipping fee.

29338 (NREL/CP–200-8098, pp. 1648-1659) **Expanding biomass power in a tough utility arena using diversified portfolio strategies.** Easterly, J.L. (DynCorp EENSP, Inc., Alexandria, VA (United States)); Andrews, C.J. National Renewable Energy Lab., Golden, CO (United States). [1995]. (CONF-9508104–: 2. meeting on biomass of the Americas, Portland, OR (United States), 21-24 Aug 1995). In *Second biomass conference of the Americas: Energy, environment, agriculture, and industry. Proceedings.* 1741p. Order Number DE95009230. Source: OSTI.

By including biomass power as a component in a diversified portfolio of power generating options, utilities can realize important benefits in managing the level of risk they face as they approach an uncertain and rapidly changing future. Following a dramatic expansion in installed biomass power capacity in the U.S. in the 1980s, biomass power has seen a sharp slow-down in the 1990s, given intense competition in the electric utility arena. With current low prices for natural gas and associated power plant technologies, the utility industry has begun moving toward a significant dependence on natural gas as their fuel of choice for the future. While on the surface this appears to be the least-cost, least-risk approach, a more comprehensive view of total fuel-cycle issues reveals many risks to this approach, such as uncertainties in future gas price stability and availability, increasing dependence on imported supplies, upstream emissions and impacts from well drilling, safety and cost risk associated with aging pipeline distribution networks, etc. By adopting a balanced portfolio approach in the slate of fuels and technologies that are used for producing electric power, a modest commitment to some use of biomass could help provide a hedge against current trends toward heavy dependence on new natural gas generating capacity. This paper presents final conclusions from a project completed by DynCorp EENSP (formerly Meridian, a DynCorp subsidiary) for the Northeast Regional Biomass Program entitled "Capturing Environmental and Economic Externalities: Evaluating the Total Fuel-Cycle Impacts of Biomass."

29339 (NREL/CP–200-8098, pp. 1713-1721) **Will the Brazilian alcohol program accomplish vehicles future demand.** Fernandes, E.L. (Univ. of Sao Paulo (Brazil)); Coelho, S.T. National Renewable Energy Lab., Golden, CO (United States). [1995]. (CONF-9508104–: 2. meeting on biomass of the Americas, Portland, OR (United States), 21-24 Aug 1995). In *Second biomass conference of the Americas: Energy, environment, agriculture, and industry. Proceedings.* 1741p. Order Number DE95009230. Source: OSTI.

The National Alcohol Program, "Proalcool", established in Brazil in 1975, nowadays faces a decisive moment due to its economic and, consequently, supply problems. Since 1989, ethanol production has not been enough for the Brazilian alcohol fueled fleet. This unbalanced situation subjects it to a loss of reliability in the Program. The supply problems are due to the controversy regarding ethanol costs. Alcohol production has been maintained almost the same, since 1988, despite a reduction of sugar cane harvested surface, by an increase in agro-industrial productivity. This paper discusses the relationship between production and demand of ethanol as a strategic gasoline substitute. Ethanol production forecasts are compared to official goals related to alcohol demand for automotive purposes, which has established a given percentage of alcohol fueled vehicle in total sales. Two scenarios adopted in this work ("conservative" and "efficient") estimate on ethanol production of 16.53 and 19.44 billion liters, respectively, for year 2015. These results, when compared to ethanol demand in the same year, 22.7 billion liters, lead to a significant deficit of alcohol. From the obtained results, measures for the adjustment of Proalcool are proposed.

0940 Transport, Handling, and Storage

29340 (NREL/CP–200-8098, pp. 100-109) **Development of a system for long hauling chaff to an ethanol facility.** Reding, B. (Prairie Agricultural Machinery Institute, Humboldt (Canada)); Leduc, P. National Renewable Energy Lab., Golden, CO (United States). [1995]. (CONF-9508104–: 2. meeting on biomass of the Americas, Portland, OR (United States), 21-24 Aug 1995). In *Second biomass conference of the Americas: Energy, environment, agriculture, and industry. Proceedings.* 1741p. Order Number DE95009230. Source: OSTI.

The Saskatchewan Research Council in conjunction with Agriculture Canada have conducted a series of projects to evaluate the feasibility of using cereal grain chaff for ethanol production. At present, chaff field collection systems exist; however, chaff's low bulk density currently makes it uneconomical to transport. High transportation costs have a significant effect on the profitability of an ethanol facility. A reduction in transportation costs or technological improvements in processing are required to make chaff an economically feasible feedstock. Development work at the Prairie Agricultural Machinery Institute (PAMI) is addressing this problem. Laboratory results indicated that long hauling of chaff may be economically feasible when using tractor trailor trucks with compacting equipment. It was determined that particle size reduction had a major impact on transportation economics. Particle orientation by blowing chaff into a bulk storage can increase the bulk density by 66%. The combination of size reduction and particle orientation may provide an effective means for densification. Further work is being conducted to assess the potential of combined size reduction and particle orientation, and to determine the most efficient means of size reduction which could be use as part of pre-transport processing of the chaff.

29341 (NREL/CP–200-8098, pp. 1324-1333) **The effect of location and facility demand on the marginal cost of delivered wood chips from energy crops: A case study of the state of Tennessee.** Graham, R.L. (Oak Ridge National Lab., TN (United States)); Liu, W.; Downing, M. National Renewable Energy Lab., Golden, CO (United States). [1995]. DOE Contract AC05-84OR21400. (CONF-9508104–: 2. meeting on biomass of the Americas, Portland, OR (United States), 21-24 Aug 1995). In *Second biomass conference of the Americas: Energy, environment, agriculture, and industry. Proceedings.* 1741p. Order Number DE95009230. Source: OSTI.

Cost-supply curves for delivered wood chips from short rotation woody crops were calculated for 21 regularly-spaced locations spanning the state of Tennessee. These curves were used to systematically evaluate the combined effects of location and facility demand on wood chip feedstock costs in Tennessee. The cost-supply curves were developed using BRAVO, a GIS-based decision support system which calculates marginal cost of delivering wood chips to a specific location given road network maps and maps of farmgate prices and supplies of woody chips from short rotation energy crops. Marginal costs of delivered chips varied by both facility location in the state and facility demand. Marginal costs were lowest in central Tennessee unless the facility demand was greater than 2.7 million dry Mg per year (3 million dry tons per year) in which case west Tennessee was the lowest cost region. Marginal costs rose rapidly with increasing facility demand in the mountainous eastern portion of the state. Transportation costs accounted for 18 to 29% of the delivered costs and ranged between $8 and $18/dry Mg ($7 and $16/dry ton). Reducing the expected farmer participation rate from 100% to 50% or 25% dramatically raised the marginal costs of feedstock supply in the east and central regions of the state. The analysis demonstrates the need to use geographically-specific information when projecting the potential costs and supplies of biomass feedstock.

29342 (NREL/CP–200-8098, pp. 1660-1669) **Biomass losses during harvest and storage of switchgrass.** Sanderson, M.A.

(Texas A&M Univ., College Station, TX (United States)); Egg, R.P.; Coble, C.G. National Renewable Energy Lab., Golden, CO (United States). [1995]. (CONF-9508104–: 2. meeting on biomass of the Americas, Portland, OR (United States), 21-24 Aug 1995). In *Second biomass conference of the Americas: Energy, environment, agriculture, and industry. Proceedings.* 1741p. Order Number DE95009230. Source: OSTI.

We determined the effects of environmental factors on switchgrass biomass stored in large round bales as affected by protected and unprotected conditions in four experiments during 1991 to 1995. Additionally, we measured the losses of dry matter during the biomass harvesting process (cutting, drying, and baling) and determined the quantity and quality of runoff waste from stored bales. In Experiments 1 and 2, 'Alamo' switchgrass was harvested in October 1991 and August 1992, respectively, and stored in 275-kg bales unprotected outside for six months. In Experiments 3 and 4, switchgrass was harvested in November of 1993 and 1994, respectively, and stored in 380-kg bales for one year. In each experiment, the biomass was field dried to less than 11 to 19% moisture and baled. Losses during baling in 1993 and 1994 were measured by collecting biomass at the baler and gleaned from the stubble. In 1993 and 1994, bales were stored inside on concrete, outside on a grass sod unprotected from the elements, or outside on a gravel pad. In each experiment, bales from each treatment were destructively sampled periodically to determine the depth of weathered biomass and composition of weathered and unweathered biomass. Most of the visible weathering in the bales occurred in the surface 7 to 15 cm in each experiment. In Experiment 2, losses during storage were 13% of the biomass initially present. In Experiment 3, there were no differences ($P > 0.05$) among outside storage treatments in losses of biomass during the 12 months (average of 4.7%). There were no biomass losses for bales stored inside. Losses of biomass during baling ranged from 1 to 5% depending on moisture concentration in the biomass at baling. Larger losses were associated with drier biomass, presumably because of more shattering. Quality and quantity of runoff water from bales were not different ($P > 0.05$) from runoff water of control plots.

0950 Environmental Aspects

Refer also to citation(s) 29214, 29228, 29242, 29294, 29306, 29330, 29336, 29353

29343 (CONF-9508104–2) **Environmental effects of planting energy crops at larger scales on agricultural lands.** Tolbert, V.R.; Downing, M. Oak Ridge National Lab., TN (United States). [1995]. 10p. Sponsored by USDOE, Washington, DC (United States). DOE Contract AC05-84OR21400. From 2. meeting on biomass of the Americas; Portland, OR (United States); 21-24 Aug 1995. Order Number DE95017441. Source: OSTI; NTIS; GPO Dep.

Increasing from research-scale to larger-scale plantings of herbaceous and short rotation woody crops on agricultural land in the United States has raised questions about the positive and negative environmental effects of farmland conversion. Research currently underway at experimental plot scales enables us examine runoff quality and quantity, erosion, and changes in soil characteristics associated with these energy crops compared to conventional row crops. A study of the fate of chemicals applied to the different crop types will enhance our knowledge of uptake, release, and off-site movement of nutrients and pesticides. Ongoing biodiversity studies in the North Central US allow us to compare differences in scale of plantings on bird and small mammal populations and habitat use. Plantings of 50–100 or more contiguous acres are needed to allow both researchers and producers to determine the benefits of including temporal energy crop rotations in the landscape. Results from these larger-scale plantings will help identify (1) the monitoring requirements needed to determine environmental effects of larger-scale plantings, (2) the best methods to determine the environmental effects of rotation length and the best crop management strategies for full-scale production. Because of the variations in soils, temperature, rainfall and other climatic conditions, as well as differences in the types of energy crops most suited for different regions, monitoring of large-scale plantings in these different regions of the US will be required to predict the environmental effects of regional agricultural land-use shifts for full-scale plantings.

29344 (CONF-9508104–3) **Environmental effects of planting biomass crops at larger scales on agricultural lands.** Tolbert, V.R.; Downing, M.E. Oak Ridge National Lab., TN (United States). [1995]. 10p. Sponsored by USDOE, Washington, DC (United States). DOE Contract AC05-84OR21400. From 2. meeting on biomass of the Americas; Portland, OR (United States); 21-24 Aug 1995. Order Number DE95017440. Source: OSTI; NTIS; GPO Dep.

Increasing from research-scale to larger-scale plantings of herbaceous. and short rotation woody crops on agricultural land in the United States has raised questions about the positive and negative environmental effects of farmland conversion. Research currently underway at experimental plot scales enables us examine runoff quality and quantity, erosion, and changes in soil characteristics associated with these energy crops compared to conventional row crops. A study of the fate of chemicals applied to the different crop types will enhance our knowledge of uptake, release, and off-site movement of nutrients and pesticides. Ongoing biodiversity studies in the North Central US allow us to compare differences in scale of plantings on bird and small mammal populations and habitat use. Plantings of 50–100 or more contiguous acres are needed to allow both researchers and producers to determine the benefits of including temporal energy crop rotations in the landscape. Results from these larger-scale plantings will help identify (1) the monitoring requirements needed to determine environmental effects of larger-scale plantings, (2) the best methods to determine the environmental effects of rotation length and the best crop management strategies for full-scale production. Because of the variations in soils, temperature, rainfall and other climatic conditions, as well as differences in the types of energy crops most suited for different regions, monitoring of large-scale plantings in these different regions of the US will be required to predict the environmental effects of regional agricultural land-use shifts for full-scale plantings.

29345 (NREL/CP–200-8098, pp. 820-829) **Environmental impacts of anaerobic digestion and the use of anaerobic residues as soil amendment.** Mosey, F.E. (VFA Services Ltd., Herts (United Kingdom)). National Renewable Energy Lab., Golden, CO (United States). [1995]. (CONF-9508104–: 2. meeting on biomass of the Americas, Portland, OR (United States), 21-24 Aug 1995). In *Second biomass conference of the Americas: Energy, environment, agriculture, and industry. Proceedings.* 1741p. Order Number DE95009230. Source: OSTI.

This paper defines the environmental role of anaerobic digestion with the overall objective of recovering energy from renewable biomass resources. Examples and opportunities for incorporating anaerobic digestion into biomass-to-energy schemes are discussed, together with environmental aspects of anaerobic digestion plants. These include visual, public amenity, pathogens and public health, odor control, and gaseous emissions. Digestate disposal and the benefits of restrictions on recycling organic wastes and biomass residues back to the land are discussed, particularly as they relate to American and European codes of practice and environmental legislation. The paper concludes that anaerobic digestion, if performed in purpose-designed reactors that efficiently recover and use biogas, if performed in purpose-designed reactors that efficiently recover and use biogas, is an environmentally benign process that can enhance energy recovery and aid the beneficial land use of plant residues in many biomass-to-energy schemes.

29346 (NREL/CP–200-8098, pp. 931-940) **Acute toxicity of biodiesel to freshwater and marine organisms.** Reece, D. (Univ. of Idaho, Moscow, ID (United States)); Peterson, C. National Renewable Energy Lab., Golden, CO (United States). [1995]. (CONF-9508104–: 2. meeting on biomass of the Americas, Portland, OR (United States), 21-24 Aug 1995). In *Second biomass conference of the Americas: Energy, environment, agriculture, and industry. Proceedings.* 1741p. Order Number DE95009230. Source: OSTI.

Biodiesel fuels are reported to be nontoxic resulting in less potential hazard to fish and other aquatic life in case of accidental spills. This paper reports on static tests with rapeseed methyl ester (RME) and rapeseed ethyl ester (REE) performed according to EPA/600/4-90/027. The acute aquatic toxicity tests were conducted

with both rainbow trout and daphnia magna by CH2M Hill in Corvallis, Oregon under contract to the University of Idaho. The LC50 (the point at which 50% have died and 50% are still alive determined by interpolation) values for each of the substrates tested with daphnia magna in parts per million were as follows: control(table salt (NaCl)) = 3.7, D2 = 1.43, RME = 23, REE = 99, and Methyl Soyate = 332. Duplicate tests with rainbow trout were run with 10 organisms per replicate. LC50 numbers were not reported because of the failure to kill a sufficient number of fish at the concentrations tested, even with the diesel control fuel. The 20 percent and 50 percent blends had scattered losses of fish but none of the tests had less than 85 percent survival at any concentrations after 96 hours.

29347 (NREL/CP–200-8098, pp. 1397-1407) **Greenhouse gas emissions from biomass burning.** Khalil, M.A.K. (Oregon Graduate Institute, Portland, OR (United States)); Rasmussen, R.A. National Renewable Energy Lab., Golden, CO (United States). [1995]. (CONF-9508104–: 2. meeting on biomass of the Americas, Portland, OR (United States), 21-24 Aug 1995). In *Second biomass conference of the Americas: Energy, environment, agriculture, and industry. Proceedings.* 1741p. Order Number DE95009230. Source: OSTI.

Biomass burning releases more than 300 identified chemical compounds into the atmosphere. Among these are the greenhouse gases CO_2, CH_4, N_2O, and O_3; and ozone-depleting compounds such as CH_3Cl and other gases that can indirectly affect the earth's climate such as CO and OCS. This paper examines the role of biomass burning on the budgets of the greenhouse gases, and the trends of biomass burning that may be indicators of the future.

29348 (NREL/CP–200-8098, pp. 1437-1445) **Strategies for reducing carbon emissions on the tropical rain forest: The case of the Brazilian Amazon.** Freitas, M.A.V. de; Rosa, L.P. National Renewable Energy Lab., Golden, CO (United States). [1995]. (CONF-9508104–: 2. meeting on biomass of the Americas, Portland, OR (United States), 21-24 Aug 1995). In *Second biomass conference of the Americas: Energy, environment, agriculture, and industry. Proceedings.* 1741p. Order Number DE95009230. Source: OSTI.

Forests systems are renewable resources that can be used by present generations and that should be available to future generations if they are exploited on a sustainable basis. The tropical forest is still an immense and unknown field. The issues are: What means a sustainable basis in the tropical rain forests? What are the means of harmonising an economic development with an environmental equilibrium in tropical regions? One way to meet this requirement is to analyse the potentially "no regrets" options on which it is possible to agree upon despite controversies about what will be the true long run costs and benefits of various courses of actions. In the case of the Brazilian Amazon, in the last thirty years, the use of biomass and land has increased rapidly. Therefore, environmental and social problems have emerged with some intensity and have had repercussions on local and global scales. In relation to the recent global environmental changes, the Brazilian Amazon is considered as a key region for biodiversity conservation and preserving a carbon sink. In this paper, the main methodological option is to conceive a set of "no-regret" options, related with the land uses and biomass valorisation, which are analysed through the same framework. The options considered here are: decrease of the great cattle ranching and of the predatory timber extraction: the increase of forest management (harvest of timber and nontimber extractive products) and forest plantations in the degraded lands. The aims to focus on three elements: job creation, technico-economic adequation and environmental impacts, with special regards concerning the limitation of the atmospheric emissions of greenhouse gases (carbon flow).

29349 (NREL/CP–200-8098, pp. 1446-1455) **Biomass-energy potential and CO_2 mitigation in Slovak Republic.** Apalovic, R. (State Forest Products Research Institute, Bratislava (Slovakia)); Violova, A. National Renewable Energy Lab., Golden, CO (United States). [1995]. (CONF-9508104–: 2. meeting on biomass of the Americas, Portland, OR (United States), 21-24 Aug 1995). In *Second biomass conference of the Americas: Energy, environment, agriculture, and industry. Proceedings.* 1741p. Order Number DE95009230. Source: OSTI.

Serious ecological problems such as the pollution of soil, water, air and forest destruction, together with greenhouse gases production may cause climatic changes (greenhouse effect). Industrial countries are turning their attention to their utilisation of renewable sources energy-mainly biomass, which reduce CO_2 emissions, because carbon cycle of bioenergy is closed. Support for the utilization of renewable sources of energy is in "Energy conception till year 2005" of Slovak government. The Slovak Republic's share on global Anthropogenic greenhouse gases emission is approximately 0.2% with annual per capita emission 11 ton CO_2 in 1990, it places Slovakia among 15 states with highest per capita emissions. The UN Framework Convention on Climate Change (FCCC) represents international co-operation in the field of global climate change. The Slovak Parliament ratified the UN FCCC in 1994. The First Slovak National Communication was elaborated by experts coordinated by Ministry of Environment in May 1995. It contains all current information concerning FCCC implementation process in Slovakia according to the Intergovernmental Panel on Climate Change (IPCC) guidelines. Slovak Republic wants to take part in U.S. Initiative on Joint Implementation, which promotes development and implementation of projects that substitute fossil fuels by biomass and another renewable energy sources and reduces greenhouse gas emissions and mitigate climate change. The data on greenhouse gases emissions presented in this report cannot be considered as final. At present, a project is under work, financed from the Environmental Fund of the Slovak Republic, from the Ministry of Environment and from the USA support within the project Country studies.

29350 (NYSERDA–95-12) **Environmental assessment of the atlas bio-energy waste wood fluidized bed gasification power plant. Final report.** Holzman, M.I. Environmental Risk Ltd., Bloomfield, CT (United States). Aug 1995. 150p. Sponsored by New York State Energy Research and Development Authority, Albany, NY (United States). Order Number DE95017408. Source: OSTI; NTIS; GPO Dep.

The Atlas Bio-Energy Corporation is proposing to develop and operate a 3 MW power plant in Brooklyn, New York that will produce electricity by gasification of waste wood and combustion of the produced low-Btu gas in a conventional package steam boiler coupled to a steam-electric generator. The objectives of this project were to assist Atlas in addressing the environmental permit requirements for the proposed power plant and to evaluate the environmental and economic impacts of the project compared to more conventional small power plants. The project's goal was to help promote the commercialization of biomass gasification as an environmentally acceptable and economically attractive alternative to conventional wood combustion. The specific components of this research included: (1) Development of a permitting strategy plan; (2) Characterization of New York City waste wood; (3) Characterization of fluidized bed gasifier/boiler emissions; (4) Performance of an environmental impact analysis; (5) Preparation of an economic evaluation; and (6) Discussion of operational and maintenance concerns. The project is being performed in two phases. Phase I, which is the subject of this report, involves the environmental permitting and environmental/economic assessment of the project. Pending NYSERDA participation, Phase II will include development and implementation of a demonstration program to evaluate the environmental and economic impacts of the full-scale gasification project.

29351 (SLU-EKOMIL-R–73) **Ion leaching and soil acidification in a forest haplic podzol: Effects of nitrogen application and clear-cutting.** Berden, M. Swedish Univ. of Agricultural Sciences, Uppsala (Sweden). Dept. of Ecology and Environmental Research. 1994. 25p. Order Number DE96703709. Source: OSTI; NTIS; INIS.

The main aim of this thesis was to investigate how small, frequently repeated applications of nitrogen affected (1) the leaching of K, Na, Ca, Mg, Mn, AlH^+, NH_4-N, NO_3-N, Cl and SO_4-S before and after clear-cutting and (2) the nutrient distribution in the plant-soil system (defined as soil plus above-ground tree biomass). Studies were conducted both in the field and in the laboratory. Two

further aims of the thesis were (3) to evaluate two speciation methods for aluminium and (4) to improve a method for determining the molecular weight distribution of dissolved organic matter. Soil solution chemistry was measured in a haplic podzol in a Norway spruce (Picea abies) site in central Sweden that had received frequent low-dose applications of ammonium nitrate (30-120 kg N ha^{-1} yr^{-1}) and superphosphate (20-40 kg P ha^{-1} every third year) during a long period (22 yr). The nitrogen load corresponded well with actual loads in central Europe. Before clear-cutting, fertilization increased concentrations of most ions in the soil solution. Total losses of NO_3-, Al and H+ increased with fertilization intensity; however, since fertilization increased tree growth, differences between the total losses of several other ions tended to decrease. After clear-cutting, nitrogen mineralization and nitrification increased, pH in the soil solution decreased, and losses of Mn and Al increased with N load. The concentration of SO_4^{2-} in soil solution decreased, probably owing to increased adsorption in the B horizon in response to the pH decrease. Biomass and soil sampling were carried out before the clear-cutting. Laboratory experiments largely confirmed results from the field experiment. It is important to evaluate the roles of surrounding ecosystems as well as the roles of different silvicultural systems. 50 refs, 2 figs, 1 tab

29352 (SLU-EKOMIL-R--80) **Soil and vegetation changes after clear-felling coniferous forests: effects of varying removal of logging residues.** Olsson, Bengt. Swedish Univ. of Agricultural Sciences, Uppsala (Sweden). Dept. of Ecology and Environmental Research. 1995. 28p. Order Number DE96703708. Source: OSTI; NTIS; INIS.

Effects of the intensity of logging residue harvesting on soil nutrient status and ground vegetation cover were examined over a 16-year period in two series of field experiments in Sweden. Short-term effects of slash harvesting and stump removal on soil water chemistry were studied after clear-felling a Norway spruce (Picea abies (L.) Karst.) stand in SW Sweden. Soil water concentrations of NH4+, and NO_3^- and K^+ were lower shortly after whole-tree harvesting (i.e. stem and slash harvesting) than shortly after conventional stem-only harvesting or complete tree harvesting (i.e. stem, slash and stump removal). However, 5 years later there were no longer differences in nutrient concentrations detected between treatments, and nutrient levels approached those normally found in drainage water from forest land. Similar studies focussed on long-term (16 years) effects were conducted on four coniferous forest sites in Sweden, two in north and the other two in the south. In each region one site was situated in a pure Scots pine stand (Pinus sylvestris L.) and the other in a pure Norway spruce stand. In general, the intensity of slash harvesting had no effect on the total pools of nitrogen or carbon in the soil. Furthermore, this study showed experimentally that the harvesting of logging residues results in long-term soil acidification and depletions of exchangeable base cations, manganese and zinc pools, which lead in turn to a reduction in base saturation levels. A major implication for practical forestry was that guidelines and recommendations concerning the large-scale utilization of logging residues should be based more on the nutritional and soil acidifying consequences of this practice than on its potential effect on soil organic matter storage. It would also be possible to mitigate the detrimental effects that slash harvesting has on site conditions by applying wood-ash or other nutrients in inorganic form. 53 refs, 4 figs, 4 tabs

0970 Legislation and Regulations

Refer also to citation(s) 29321, 29323, 29325, 29326, 29328, 29329

0980 Waste Management

Refer also to citation(s) 29200, 29202, 29261, 29262, 29293, 29294, 29295, 29296, 29299, 29345, 29438, 29439, 29440, 29961, 29962, 29964, 29965

29353 (NREL/CP--200-8098, pp. 168-177) **Characterization of wood ash and its regulations for land applications in Great Lakes region.** Rughani, J. (Michigan Technological Univ., Houghton, MI (United States)); Diebel, J.; McGinnis, G. National Renewable Energy Lab., Golden, CO (United States). [1995]. Grant CGLC-93-025. (CONF-9508104--: 2. meeting on biomass of the Americas, Portland, OR (United States), 21-24 Aug 1995). In *Second biomass conference of the Americas: Energy, environment, agriculture, and industry. Proceedings.* 1741p. Order Number DE95009230. Source: OSTI.

A serious barrier to the increased use of biomass fuels is the problem of ash disposal. The most cost effective way to dispose of wood ash is to apply/spread it on agricultural land. The ash buffers and acts as a source of fertilizer, avoiding the high cost of land filling. However, there are serious concerns by some state regulating agencies on the direct application of wood ash on soils. These concerns are based on the uncertainty of wood ash components and the environmental fate of heavy metals and organic compounds present in wood ash. All the Great Lakes states studied in this report approved the land application of wood ash. However, each state had different analytical requirements for the wood ash characterization to obtain permit for land application. This report summarizes the state regulatory status of wood ash, agencies and persons to contact regarding the permitting procedures for land applications. Also summarized are various types of analyses which are required for wood ash and the soil before the land application permit is approved. As part of this study, wood ash from 45 industrial sties in the Great Lakes region were collected to characterize the wood ash generated using different type of fuels, wood species, sources, fuel mix, burners etc. A wide variation in the wood ash results were observed. No apparent correlation was found with the wood ash results generated between the different types of fuels, species, fuel mix, burners, large or small generators etc.

29354 (NREL/CP--200-8098, pp. 178-187) **Organic waste recycling to short rotation wood crops.** Riddell-Black, D.M. (WRc plc, Buckinghamshire (United Kingdom)). National Renewable Energy Lab., Golden, CO (United States). [1995]. (CONF-9508104--: 2. meeting on biomass of the Americas, Portland, OR (United States), 21-24 Aug 1995). In *Second biomass conference of the Americas: Energy, environment, agriculture, and industry. Proceedings.* 1741p. Order Number DE95009230. Source: OSTI.

The current European use of inorganic fertilisers (n, P_2O_5 + K_2O) amounts of 18.8 M tonnes per year, 92% of which could be substituted for by animal wastes on the basis of nutrients supplied. Substantial changes are taking place in the agricultural industry as land is taken out of food production and the area under non-food crops increases. Biomass energy crops may potentially form a substantial proportion of the alternative uses of agricultural land. Where these crops require fertiliser addition to optimise yield, organic wastes should be considered as low cost, low energy alternatives to inorganic fertilisers. With correct planning and information provision, the expansion of short rotation wood crops may present the first opportunity to automatically regard organic wastes as the preferred nutrient source, and hence begin this process of inorganic fertiliser substitution. Short rotation wood crops are also being developed as dedicated outlets and treatment systems for organic wastes and wastewaters. They offer an attractive option to farmers for whom the installation of waste treatment facilities can involve substantial investment for no direct economic return. Waste treatment and disposal on wood crops provides the farmer with an income from the wood generated. Hence the development of such systems may encourage better waste management. A number of developmental systems have been installed. It is anticipated that at the current lead of understanding, systems will predominantly be relatively small, a few tens of hectares, and extensive in terms of hydraulic and nutrient loading rates. The ash produced by the combustion of fuelwood, has a fertiliser value and its is desirable that this be recycle to ensure that this renewable energy source is managed to minimise any potentially negative environmental impacts. The benefits and problems of ash recycling are briefly described.

29355 (NREL/CP--200-8098, pp. 400-409) **Operation of a direct-fired combustion turbine system on pulverized wood.** McCarroll, R.L. (Power Generating, Inc., Forth Worth, TX (United States)); Partanen, W.E. National Renewable Energy Lab., Golden, CO (United States). [1995]. (CONF-9508104--: 2. meeting on biomass of the Americas, Portland, OR (United States), 21-24 Aug 1995). In *Second biomass conference of the Americas: Energy,*

environment, agriculture, and industry. Proceedings. 1741p. Order Number DE95009230. Source: OSTI.

Power Generating, Inc. has designed, built and by July, 1995, expects to be operating a solid fuel-fired, combustion turbine system. This work is being conducted at the Western Research Institute in Laramie, Wyoming, with primary backing from the U.S. Department of Energy. This presentation will review overall design and discuss selected equipment components incorporated in the prototype system. Construction of the facility and prototype system will be illustrated through the use of photographs and actual construction drawings. The operational status of the system will be discussed as well as problems that have been encountered during initial start-up and operation. The presentation will also review test results to date and describe plans for future testing.

29356 (NREL/CP–200-8098, pp. 410-418) **Drying and burning wood waste using pulse combustion.** Buckkowski, A.G. (Novadyne Ltd., Ontario (Canada)); Eng, P.; Kitchen, J.A. National Renewable Energy Lab., Golden, CO (United States). [1995]. (CONF-9508104–: 2. meeting on biomass of the Americas, Portland, OR (United States), 21-24 Aug 1995). In *Second biomass conference of the Americas: Energy, environment, agriculture, and industry. Proceedings.* 1741p. Order Number DE95009230. Source: OSTI.

Development of an industrial dryer using pulse combustion as a heating source for drying wood waste has continued. Pulse combustion offers the advantage of high heat transfer, efficient combustion, low NOx emissions and a source of kinetic energy for providing a motive force for a drying system. In our experiments, the drying system consists of a pulse combustor and a vertical drying column. The wood waste is injected into the exhaust gases from the combustor where the turbulence created by the pulsations enhance the drying process by reducing the boundary layer thicknesses. The material is further dried in the vertical drying column, then separated from the conveying airstream using a cyclone. The paper discusses two aspects of the drying system. Firstly, the performance of the drying tests are reviewed. Tests with the 1,000,000 BTU/hr test rig have shown that a gas-fired pulse combustion dryer can dry materials such as sawdust and pulverized hog fuel from a moisture content of 50% down to a 30% in a single pass, or further with multiple passes, without scorching or burning. Preliminary figures show that the operating costs of the dryer are reduced due to the kinetic energy created by the pulse combustor which offsets the use of electricity. Secondly, it has been shown that a pulse combustor can be fired with wood waste and thereby providing the potential to displace natural gas or propane as a fuel. The development of the wood burning combustor is reviewed.

29357 (NREL/CP–200-8098, pp. 439-448) **Possibilities for increasing the power generation with biomass in pulp and paper mills.** Nousiainen, I.K. (OTATECH Ltd. Jyvaeskylae (Finland)). National Renewable Energy Lab., Golden, CO (United States). [1995]. (CONF-9508104–: 2. meeting on biomass of the Americas, Portland, OR (United States), 21-24 Aug 1995). In *Second biomass conference of the Americas: Energy, environment, agriculture, and industry. Proceedings.* 1741p. Order Number DE95009230. Source: OSTI.

Even today the share of wood derived fuels in the Finnish energy supply is significant and it is higher than in any other industrialized western country. The energy content of wood derived fuels used in 1993 was equivalent to 4.36 million toe. The wood raw material used in pulp and paper mills is harvested by log-length method, in which the trees are delimbed and bucked to timber assortments at the stump prior to subsequent transport to the road side. The long-distance transport to the mills is performed by truck-trailers. Debarking takes place in debarking drums, after which the bark-free stemwood is chipped to clean chips for pulping. The bark is removed from any drum, shredded, mechanically dried and conveyed to the power plant for energy production. In order to increase the amount of wood fuel in proportion to raw wood material various integrated harvesting methods are being developed. On the other hand, the pulp and paper mills are seen as a significant potential sector for increasing the use of wood fuel in energy production. Forest management in Finland is characterized by two or three selective thinnings during rotation period. Integrated harvesting methods can be applied to the first thinnings and to the spruce-dominant regeneration fellings. The annual potential of wood fuel production with integrated harvesting methods is in the first thinnings 0.9-1.2 million toe and in the spruce-dominant regeneration fellings 0.6-0.8 million toe. The increased amount of wood fuel allows mills either to decrease the amount of purchased fuel or with new power plant technologies the amount of purchased power. In the typical pulp and paper mills the energy content of additional wood fuel produced with integrated harvesting methods can be 50-60 MW. By pressurized gasification of bark and additional wood fuel, by integrated methods and from other mills, the power generation can be increased with 70-90 MW.

29358 (NREL/CP–200-8098, pp. 565-575) **Thermic and electric power production and use from gasification of biomass and RDF: Experience at CFBG Plant at Greve in Chianti.** Barducci, G.L. (SAFI, Florence (Italy)); Daddi, P.; Polzinetti, G.C. National Renewable Energy Lab., Golden, CO (United States). [1995]. (CONF-9508104–: 2. meeting on biomass of the Americas, Portland, OR (United States), 21-24 Aug 1995). In *Second biomass conference of the Americas: Energy, environment, agriculture, and industry. Proceedings.* 1741p. Order Number DE95009230. Source: OSTI.

With the gasification plant of Greve in Chianti, it is easy to produce electric power, starting from sorghum bagasse and RDF. The experiment demonstrated the possibility of gasifying the biomass sorghum bagasse in CFBG, obtaining a low gas with a sufficiently high heat value. It is possible to use the lean gas, obtained from gasification of sorghum bagasse and RDF, as fuel in the cement production. With the realization of the second line of gas combustion and heat recovery system, the plant will be able to produce electric power of 6,7 MW and thermic treatment about 200 ton/day of RDF or biomass. At the same time the new configuration of the second line will be able to avoid the fouling problems on the boiler section.

29359 (NREL/CP–200-8098, pp. 594-606) **Gasification of biomass wastes and residues for electricity production in the Netherlands.** Faaij, A. (Utrecht Univ. (Netherlands)); Curvers, A.; Doorn, J. van. National Renewable Energy Lab., Golden, CO (United States). [1995]. (CONF-9508104–: 2. meeting on biomass of the Americas, Portland, OR (United States), 21-24 Aug 1995). In *Second biomass conference of the Americas: Energy, environment, agriculture, and industry. Proceedings.* 1741p. Order Number DE95009230. Source: OSTI.

The technical and economic feasibility and environmental performance of atmospheric gasification for electricity production of biomass wastes and residues is investigated for Dutch conditions. The potential of biomass wastes and residues in The Netherlands amounts over 100 PJ/yr. Characteristics, supply during the year, degree of contamination and (negative) costs differ widely per stream: between minus 10-6 ECU/GU (HHV) (**). An ACFB/CC system based on the General Electric LM 2500 gas turbine and TPS atmospheric gasification technology, including the flue gas drying and low temperature gas cleaning is selected. The system performance is assessed for clean wood, verge grass, organic domestic waste, demolition wood and a wood sludge mixture. Integral systems calculations are performed by using an ASPEN$^+$ model. Fuel gas compositions for various fuels were derived by lab scale gasification tests of various fuels and model calculations. The net calculated system efficiencies lies between 35.4-40.3% (LHV) for various fuels, with significant potential for further optimization. Estimated investment costs based on suppliers information amount 1500-2400 ECU/kW-installed, the upper range representing a first plant, the lower the cost level on longer term. Electricity production costs, including logistics and (negative) fuel price vary between minus 6.7-8.5 ECU ct/kWh, the negative values caused by present waste treatment being a source of income to the conversion facility. Environmental performance is expected to meet the worlds' most stringent standards on waste incineration and the system seems flexible enough to process a wide variety of fuels. The economic analysis showed a high sensitivity of the kWh costs for the system efficiency but very most sensitivity for transport distance which

pleads for application of larger scale plants. As a waste treatment option this concept seems to beat all alternatives presently applied.

29360 (NREL/CP–200-8098, pp. 711-723) **Anaerobic digestion of municipal, industrial, and livestock wastes for energy recovery and disposal.** Sax, R.I. (Biothane Corporation, Camden, NJ (United States)); Lusk, P.D. National Renewable Energy Lab., Golden, CO (United States). [1995]. (CONF-9508104–: 2. meeting on biomass of the Americas, Portland, OR (United States), 21-24 Aug 1995). In *Second biomass conference of the Americas: Energy, environment, agriculture, and industry. Proceedings.* 1741p. Order Number DE95009230. Source: OSTI.

The degradation of carbonaceous organic material by anaerobic bacteria leads to the production of methane gas (biogas) at the theoretical stoichiometric conversion rate of 0.35-cubic meters of methane per kilogram of Chemical Oxygen Demand (COD) reasonably close proximity to the site of this digestion process. The untreated biogas generated from anaerobic digestion typically contains from 55% to 75% methane content, with the balance consisting mainly of carbon dioxide and a small, but important, amount of hydrogen sulfide. The untreated biogas is normally saturated with water vapor at the temperature of the digestion process which typically is in the mesophilic range 25 to 38 degrees Celsius. This overview paper describes the types of anaerobic technologies which are presently used for the digestion of various type of municipal, industrial and livestock manure wastes, summarizes the principal developments which have taken place in the field during the past several years, and discusses the energy recovery economics for each of the three usage applications. The paper stratifies the use of anaerobic digestion technology for the treatment of wastewaters from industry (an application which has increased dramatically during the past decade) by geographical region, by industry type, very various categories of food processing, and by technology type, in all cases taking account of system size to emphasize the economics of energy production.

29361 (NREL/CP–200-8098, pp. 791-800) **Animal and industrial waste anaerobic digestion: USA status report.** Lusk, P.D. (Resource Development Associates, Washington, DC (United States)). National Renewable Energy Lab., Golden, CO (United States). [1995]. (CONF-9508104–: 2. meeting on biomass of the Americas, Portland, OR (United States), 21-24 Aug 1995). In *Second biomass conference of the Americas: Energy, environment, agriculture, and industry. Proceedings.* 1741p. Order Number DE95009230. Source: OSTI.

Pollutants from unmanaged animal and bio-based industrial wastes can degrade the environment, and methane emitted from decomposing wastes may contribute to global climate change. One waste management system prevents pollution and converts a disposal problem into a new profit center. Case studies of operating systems indicate that the anaerobic digestion of animal and industrial wastes is a commercially available bioconversion technology with considerable potential for providing profitable coproducts, including a cost-effective renewable fuel. Growth and concentration of the livestock industry create opportunities to properly dispose of the large quantities of manures generated at dairy, swine, and poultry farms. Beyond the farm, extension of the anaerobic digestion process to recover methane has considerable potential for certain classified industries with a waste steam characterization similar to livestock manures. More than 35 example industries have been identified, and include processors of chemicals, fiber, food, meat, mil, and pharmaceuticals. Some of these industries already recover methane for energy. This status report examines some current opportunities for recovering methane from the anaerobic digestion of animal and industrial wastes in the U.S. Case studies of operating digesters, including project and maintenance histories, and the operator's "lessons learned," are included as a reality check. Factors necessary for successful projects, as well as a list of reasons explaining why some anaerobic digestion projects fail, are provided. The role of management is key; not only must digesters be well engineered and built with high-quality components, they must also be sited at facilities willing to incorporate the uncertainties of a new technology. Anaerobic digestion can provide monetary benefits and mitigate possible pollution problems, thereby sustaining development while maintaining environmental quality.

29362 (NREL/CP–200-8098, pp. 830-839) **Economic viability of anaerobic digestion.** Wellinger, A. (INFOENERGIE, Ettenhausen (Switzerland)). National Renewable Energy Lab., Golden, CO (United States). [1995]. (CONF-9508104–: 2. meeting on biomass of the Americas, Portland, OR (United States), 21-24 Aug 1995). In *Second biomass conference of the Americas: Energy, environment, agriculture, and industry. Proceedings.* 1741p. Order Number DE95009230. Source: OSTI.

The industrial application of anaerobic digestion is a relatively new, yet proven waste treatment technology. Anaerobic digestion reduces and upgrades organic waste, and is a good way to control air pollution as it reduces methane and nitrous gas emissions. For environmental and energy considerations, anaerobic digestion is a nearly perfect waste treatment process. However, its economic viability is still in question. A number of parameters-type of waste (solid or liquid), digester system, facility size, product quality and end use, environmental requirements, cost of alternative treatments (including labor), and interest rates-define the investment and operating costs of anaerobic digestion facility. Therefore, identical facilities that treat the same amount and type of waste may, depending on location, legislation, and end product characteristics, reveal radically different costs. A good approach for evaluating the economics of anaerobic digestion is to compare it to treatment techniques such as aeration or conventional sewage treatment (for industrial wastewater), or composting and incineration (for solid organic waste). For example, the cost (per ton of waste) of in-vessel composting with biofilters in somewhat higher than that of anaerobic digestion, but the investment costs 11/2 to 2 times more than either composting or anaerobic digestion. Two distinct advantages of anaerobic digestion are: (1) it requires less land than either composting or incinerating, which translates into lower costs and milder environmental and community impacts (especially in densely populated areas); and (2) it produces net energy, which can be used to operate the facility or sold to nearby industries.

0990 Products and By-Products

Refer also to citation(s) 29204

29363 (ANL/ES/VU–87091) **Novel membrane technology applications and "green" product development for industrial pollution prevention. Bioconversion of high-starch food wastes into high-value products.** Tsai, Shih-Perng. Argonne National Lab., IL (United States). [1995]. 10p. Sponsored by USDOE, Washington, DC (United States). DOE Contract W-31-109-ENG-38. (CONF-9506231–10-Vugraphs: 1995 Energy Systems Division meeting, Argonne, IL (United States), 6-7 Jun 1995). Order Number DE95015855. Source: OSTI; NTIS; GPO Dep.

This report consists of a copy of slides presented at the meeting.

29364 (NREL/CP–200-8098, pp. 1121-1129) **Biosynthesis of indigo using recombinant E. coli: Development of a biological system for the cost-effective production of a large volume chemical.** Berry, A. (Genecor International, Rochester, NY (United States)); Battist, S.; Chotani, G. National Renewable Energy Lab., Golden, CO (United States). [1995]. (CONF-9508104–: 2. meeting on biomass of the Americas, Portland, OR (United States), 21-24 Aug 1995). In *Second biomass conference of the Americas: Energy, environment, agriculture, and industry. Proceedings.* 1741p. Order Number DE95009230. Source: OSTI.

Cost-effective production of any large-volume chemical by fermentation requires extensive manipulation of both the production organism and the fermentation and recovery processes. We have developed a recombinant E. coli system for the production of tryptophan and several other products derived from the aromatic amino acid pathway. By linking our technology for low-cost production of tryptophan from glucose with the enzyme naphthalene dioxygenase (NDO), we have achieved an overall process for the production of indigo dye from glucose. To successfully join these two technologies, both the tryptophan pathway and NDO were extensively modified via genetic engineering. In addition, systems were developed to remove deleterious by-products generated during the chemical oxidations leading to indigo formation. Low-cost fermentation processes were developed that utilized minimal-salts media containing glucose as the sole carbon source. Finally, economical

recovery processes were used that preserved the environmental friendliness of the biosynthetic route to indigo.

29365 (NREL/CP–200-8098, pp. 1130-1140) **Metabolic engineering and applications of polyhydroxyalkanoates (PHAs).** Williams, S.F. (Metabolix, Inc., Cambridge, MA (United States)); Gerngross, U.T.; Peoples, O.P. National Renewable Energy Lab., Golden, CO (United States). [1995]. (CONF-9508104–: 2. meeting on biomass of the Americas, Portland, OR (United States), 21-24 Aug 1995). In *Second biomass conference of the Americas: Energy, environment, agriculture, and industry. Proceedings.* 1741p. Order Number DE95009230. Source: OSTI.

Polyhydroxyalkanoates (PHAs) have been recognized for many years as naturally occurring biodegradable plastics. The PHA plastics range from those that resemble polypropylene to other that are more elastomeric. A fundamental understanding of the genetic and biochemical pathways involved in PHA synthesis has now made it possible to produce PHAs commercially at an attractive cost and scale, using Metabolix's transgenic technology. This technology, which was pioneered at The Massachusetts Institute of Technology, allows PHAs to be produced in the short-term by highly efficient fermentation systems, and ultimately, in plant crops. Production of PHAs in plant crops offers the promise of costs competitive with petroleum derived polymers. Millions of acres of transgenic plant crops could provide millions of tonnes of PHAs, increasing the use of renewable resources, and decreasing the U.S. reliance on imported oil. Furthermore, through the production of new PHA products, this technology provides new outlets to expand the U.S. industrial agricultural base. An overview of the scientific and industrial importance of PHAs, including the molecular genetics, biosynthesis, applications, and markets for these materials will be presented.

29366 (NREL/CP–200-8098, pp. 1141-1150) **Phenol-formaldehyde resin substitutes from biomass tars.** Himmelblau, D.A. (Biocarbons Corporation, Woburn, MA (United States)). National Renewable Energy Lab., Golden, CO (United States). [1995]. (CONF-9508104–: 2. meeting on biomass of the Americas, Portland, OR (United States), 21-24 Aug 1995). In *Second biomass conference of the Americas: Energy, environment, agriculture, and industry. Proceedings.* 1741p. Order Number DE95009230. Source: OSTI.

Approximately 320,000 tonnes of phenol and formaldehyde are currently used annually in North America to make adhesive resins that are used to make exterior-grade structural panels. The demand for phenol-formaldehyde (PF) resins is growing faster than the demand for panels, because more adhesive is required to join/coat the surface of wood flakes (for oriented strand board - OSB) than is required to join veneer; OSB is replacing plywood as logs large enough for veneer become scarcer. Also, competitive uses for phenol and methanol (for making formaldehyde) have increased raw materials cost and threatened availability. Production of adhesive resins from biomass to reduce reliance on raw materials derived from commodity petrochemicals and to lower resin cost looks attractive. A simple fluidized-bed reactor system can be used to produce tars that can substitute for a major portion of the phenol and formaldehyde in PF resin adhesives. This can be done in an air-fluidized, single-bed reactor; no inert gas or dual-bed system is required. The key is recognizing that optimum phenolic character in the tar is not produced at the maximum tar yield, but at reactor temperatures around 600°C and short gas-phase residence times that produce a yield of about 25 to 30 weight percent. A wide range of phenols, aldehydes and other compounds capable of polymerization are produced. Feedstock can be any wood waste larger than sander dust; low cost agricultural wastes such as bagasse are also suitable. Adhesive resin is produced from the entire tar product by shifting the pH from acidic to basic with NaOH, and combining and heating the resulting resole with phenol and formaldehyde, similarly to conventional resins. Approximately half of the phenol and formaldehyde by weight can be replaced with tar. A plant producing 13,865,000 kg (30,566,000 lb) annually from 308 tonnes (340 tons) per day of green wood chips would cost approximately $8,400,000.

29367 (NREL/CP–200-8098, pp. 1161-1170) **Conversion of lignin into a precursor for the production of graphitic carbon materials.** Nelson, C.M. (AFR, Inc., East Hartford, CT (United States)); Serio, M.A.; Kroo, E. National Renewable Energy Lab., Golden, CO (United States). [1995]. (CONF-9508104–: 2. meeting on biomass of the Americas, Portland, OR (United States), 21-24 Aug 1995). In *Second biomass conference of the Americas: Energy, environment, agriculture, and industry. Proceedings.* 1741p. Order Number DE95009230. Source: OSTI.

Lignin is the most abundant renewable aromatic material. There are roughly 25 x 10^6 tons of lignin produced each year as a byproduct of pulp and papermaking which has a fuel value of between $0.00 and $0.04 per pound. Carbon materials are among the highest value products can be produced from lignin. Consequently, the development of processes which can utilize lignins for carbon fibers or the production of other high value carbon materials has the potential for a high payoff. It would also result in the utilization of lignin as a raw material for high technology, internationally competitive industries. The ability to form graphitic carbon materials from pitch depends on the development of a liquid crystal system called mesophase. A major problem with using lignin as a precursor for the production of mesophase pitch is the high oxygen functional group concentration of lignin which makes it reactive toward crosslinking. Hydrothermal treatment of lignin allows for selective removal of the reactive oxygen functional groups from lignin which normally prevent extensive mesophase formation. Hydrothermal pretreatment of lignin substantially increases the mesophase content of lignin-derived pitch. This development will make lignin a suitable precursor for a range of carbon materials applications.

29368 (NREL/CP–200-8098, pp. 1171-1180) **Recent developments in annual growth lignocellulosics as reinforcing fillers in thermoplastics.** Jacobson, R.E. (Forest Products Lab., Madison, WI (United States)); Caulfield, D.F.; Rowell, R.M. National Renewable Energy Lab., Golden, CO (United States). [1995]. Grant 9303555. (CONF-9508104–: 2. meeting on biomass of the Americas, Portland, OR (United States), 21-24 Aug 1995). In *Second biomass conference of the Americas: Energy, environment, agriculture, and industry. Proceedings.* 1741p. Order Number DE95009230. Source: OSTI.

Recent interest in reducing the environmental impact of materials is leading to the development of newer agricultural based materials that can reduce the stress to the environment. Several billion pounds of fillers and reinforcements are used annually in the plastics industry and their use is likely to increase, to reduce the amount of plastics used in a product, with improved compounding technology and new coupling agents. The use of lignocellulosic fibers (eg. kenaf, jute, etc.) as reinforcing fillers in plastics has generated significant interest in recent years. The use of lignocellosic fibers permit the use of high volume fillings due to their lower densities and non-abrasive properties, and therefore reduces the use of plastics in a product. The specific tensile and flexural moduli of a 50% weight of glass fiber-PP injection molded composite and are superior to typical calcium carbonate or talc based PP composites. Results indicate that annual growth lignocellulosic wastes and fibers are viable reinforcing fillers as long as the right processing conditions and aids are used, and for applications where the higher water absorption of the agro-base fiber composite is not critical.

29369 (NREL/CP–200-8098, pp. 1181-1189) **Agricultural fibres for pulp and paper manufacture in developed countries.** Wong, A. (Arbokem, Inc., Vancouver (Canada)). National Renewable Energy Lab., Golden, CO (United States). [1995]. (CONF-9508104–: 2. meeting on biomass of the Americas, Portland, OR (United States), 21-24 Aug 1995). In *Second biomass conference of the Americas: Energy, environment, agriculture, and industry. Proceedings.* 1741p. Order Number DE95009230. Source: OSTI.

Agricultural fibres are routinely used for the manufacture of paper products in developing countries. The agriculture (non-wood) pulp industry accounts more than 50% of the national pulp production in China and in India. In contrast, paper manufacturers of the developed countries have relied largely on wood pulp fibres since the 1950's. During the past 3 decades, the global wood pulp production capacities has expanded substantially. There is a renewed interest to use agriculture-based fibres in place of wood, for the production of pulp and paper in developing countries. The alternative is

driven, in part, by the growing shortage of commercial wood supply as caused by the over-cutting of the standing forest and the accelerated re-allocation of forest land for ecological and recreational uses. Although the shortage of wood supply can be alleviated partially by the adoption of higher-yield wood pulping technologies and by the increased use of waste paper. But ultimately, these remedial steps will be inadequate to meet the growing demand for paper products. There are several important factors which affect the use of agricultural fibres for pulp and paper manufacture in developed countries. For some on-purpose fibre crops, continued farm subsidy and repeal of certain sections of the Narcotics Act would be required. Agri-pulp production from agricultural cropping residues appears to be the most practical economic means to supplement the fibre needs of the paper industry. In the social context, agri-pulp implementation in North America would also provide lower taxes that would be accrued from the elimination of substantial annual subsidies to grain farmers from the government.

29370 (NREL/CP–200-8098, pp. 1210-1218) **Copolymer resins made of agricultural and forest residues extracts for wood laminating adhesives.** Chen, C.M. (Univ. of Georgia, Athens, GA (United States)). National Renewable Energy Lab., Golden, CO (United States). [1995]. (CONF-9508104–: 2. meeting on biomass of the Americas, Portland, OR (United States), 21-24 Aug 1995). In *Second biomass conference of the Americas: Energy, environment, agriculture, and industry. Proceedings.* 1741p. Order Number DE95009230. Source: OSTI.

Extracts of Southern pine bark, peanut hulls, pecan nut pitch, and pecan shell flour were used to synthesize copolymer resins using resorcinol, phenol, and formaldehyde. The test joints of both southern pine and oak were laminated in room temperature. The gluability of these copolymer resins were evaluated with shear compression loading test. The effects of resorcinol level, the molar ratio of formaldehyde to phenolic, and the composition of the hardener on bonding quality were investigated. With a more than 80% wood failure after vacuum pressure treatment, several copolymer resins provided good bonding quality as a wood laminating adhesive. Different extracts required different formulations of copolymer resin and hardner to obtain the best bonding quality.

29371 (NREL/CP–200-8098, pp. 1219-1227) **United States based agricultural "waste products" as fillers in a polypropylene homopolymer.** Jacobson, R.E. (Forest Products Lab., Madison, WI (United States)); Rowell, R.M.; Caulfield, D.F. National Renewable Energy Lab., Golden, CO (United States). [1995]. (CONF-9508104–: 2. meeting on biomass of the Americas, Portland, OR (United States), 21-24 Aug 1995). In *Second biomass conference of the Americas: Energy, environment, agriculture, and industry. Proceedings.* 1741p. Order Number DE95009230. Source: OSTI.

With the advent of modern coupling agents (MAPP or maleic anhydride grafted polypropylene), the potential use of various types of renewable, sustainable agricultural byproducts as fillers in thermoplastics is explored. Over 7.7 billion pounds of fillers were used in the plastics industry in 1993. With sharp price increases in commodity thermoplastics (i.e. approximately 25% in 94'), the amount of fillers in thermoplastic materials will increase throughout the 90's. Various types of agricultural fibers are evaluated for mechanical properties vs. 50% wood flour and 40% talc filled polypropylene (PP). The fibers included in this study are: kenaf core, oat straw, wheat straw, oat hulls, wood flour (pine), corncob, hard corncob, rice hulls, peanut hulls, corn fiber, soybean hull, residue, and jojoba seed meal. Composite interfaces were modified with MAPP to improve the mechanical properties through increased adhesion between the hydrophilic and polar fibers with the hydrophobic and non-polar matrix. The agro-waste composites had compositions of 50% agro-waste/48% PP/2% MAPP. All of the agricultural waste by-products were granulated through a Wiley mill with a 30 mesh screen and compounded in a high intensity shear-thermo kinetic mixer. The resultant blends were injection molded into ASTM standard samples and tested for tensile, flexural, and impact properties. This paper reports on the mechanical properties of the twelve resultant composites and compares them to wood flour and talc-filled polypropylene composites. The mechanical properties of kenaf core, oat straw, wheat straw, and oat hulls compare favorably to the wood flour and talc-filled PP, which are both commercially available and used in the automotive and furniture markets.

29372 (NREL/CP–200-8098, pp. 1236-1244) **Control of the structure and properties of a frost-resistant fiber-cement building plate on the basis of waste cellulose fibers.** Telysheva, G. (State Institute of Wood Chemistry, Riga (Latvia)); Dizhbite, T.; Arshanitsa, A. National Renewable Energy Lab., Golden, CO (United States). [1995]. (CONF-9508104–: 2. meeting on biomass of the Americas, Portland, OR (United States), 21-24 Aug 1995). In *Second biomass conference of the Americas: Energy, environment, agriculture, and industry. Proceedings.* 1741p. Order Number DE95009230. Source: OSTI.

Different aspects of the application of environmentally friendly fibers of the plant origin in building materials instead of the cancerogenic asbestos fiber have been studied. A whole range of the investigations have been performed, and some developments have been patented and produced on an industrial scale. The object of the present work is the use of the waste cellulose-containing fiber material instead of asbestos in the production of the fiber-cement material and the development of a technique of the control of its structure and properties depending on the content of non-cellulosic admixtures in fiber materials. A formulation of mixtures and a method of obtaining building plates, in which various types of recycling paper are used, have been developed and tested under industrial conditions. Techniques enhancing the compatibility of the raw material mixture components have been developed. A range of organic and inorganic additives enhancing the physico-mechanical characteristics of the materials have been proposed for various stages of the process. An enhanced frost-resistance of the material, as compared to asbestos-cement plates, is explained by the formation of the close porous structure as well as the change of the tension relaxation mechanism.

29373 (NREL/CP–200-8098, pp. 1245-1254) **Mechanical properties and potential commercial applications of agricultural composites.** Asadi, M. (Meetech Corp., Lawrence, KS (United States)); Farokhi, S.; McCabe, S.L. National Renewable Energy Lab., Golden, CO (United States). [1995]. (CONF-9508104–: 2. meeting on biomass of the Americas, Portland, OR (United States), 21-24 Aug 1995). In *Second biomass conference of the Americas: Energy, environment, agriculture, and industry. Proceedings.* 1741p. Order Number DE95009230. Source: OSTI.

This paper reveals information on the mechanical properties of the agricultural composites and their commercial potential as a substitute for plastics and woods leading to a lower cost for these products. Chopped and particulate agricultural co-products (hereafter referred to agro-fibers) such as wheat, brome hay, switchgrass, and corn were mixed at a ratio of 66:34 fiber/epoxy by volume to manufacture agricultural composites (hereafter referred to agrocomposites) using the hand lay-up molding technique. The manufactured composite samples were tested for their mechanical properties such as tensile stress, compressive stress, moisture absorption, and thermal expansion. According to results, chopped switchgrass agro-composite samples showed the highest tensile strength, yet less than that of soft woods and slightly higher than that of plastics (high density polyethylene known as HDPE). As a result, a second set of agro-composite samples using only chopped switchgrass was manufactured at 10%, 20%, 30%, 40%, and 50% agro-fiber content to obtain the optimal fiber/epoxy ratio for which agro-composite samples show the maximum tensile stress. The same procedure was followed for comprehensive strength, thermal expansion, and moisture absorption measurements. According to the obtained results, at 50:50, agro-composite samples showed the highest tensile stress at 2,925 psi compared to that of plastic at 2,000 psi and of soft wood at 6,600 psi. At 10:90 agro-fiber/epoxy, compressive strength of the agro-composite samples were 60% higher than that of plastic and 80% higher than that of soft woods. Thermal expansion and moisture absorption of the manufactured agro-composite samples showed better performances than both woods and plastics. Optimized agro-composite samples, due to their cost competitiveness and low weight, could replace woods and plastics in some applications. A small fraction of plastic and wood market wood lead to new source of revenues for farmers.

10 SYNTHETIC FUELS

1002 Production

Refer also to citation(s) 28605, 28624, 28625, 28741, 28742, 28743

29374 (ETDE/CH-mf–95787322, pp. 6-8) **Design of a high-pressure laboratory reactor and analytical interface for on-line reaction monitoring.** Bill, A. (Paul Scherrer Inst. (PSI), Villigen (Switzerland)); Uenala, E.; Highfield, J.G. Paul Scherrer Inst. (PSI), Villigen (Switzerland). 1995. In *Paul Scherrer Institut annual report 1994. Annex V: PSI general energy technology newsletter 1994.* 123p. Source: OSTI; NTIS.

A high-pressure laboratory reactor is an essential research facility for the Catalysis Laboratory, enabling testing of catalysts for alcohols synthesis from CO_2 and steam-reforming (S-R) at a scale two orders of magnitude higher than existing micro-reactor equipment. The reactor concept is outlined and the layout and experimental methodology is described, including development of the on-line interface to infrared and mass spectrometric detectors, and analytical method optimization. Operational status of the whole system was verified by checking the consistency of performance data for a commercial methanol S-R catalyst with the manufacturer's specifications. (author) 2 figs., 7 refs.

29375 (ETDE/CH-mf–95787322, pp. 9-12) **Improvements in the yield of methanol synthesis from CO_2 and H_2 by using permselective membrane at 200°C.** Struis, R. (Paul Scherrer Inst. (PSI), Villigen (Switzerland)); Stucki, S.; Wiedorn, M. Paul Scherrer Inst. (PSI), Villigen (Switzerland). 1995. In *Paul Scherrer Institut annual report 1994. Annex V: PSI general energy technology newsletter 1994.* 123p. Source: OSTI; NTIS.

The yield of methanol synthesis from CO_2 and H_2 as a chemical energy storage reaction is limited by equilibrium at the temperatures required by state-of-the-art catalysts. Substantial conversion improvements would be achieved by selective product separation from the catalyst bed of a synthesis reactor. The capability of the Li-Nafion membrane to separate products from a commercially available catalyst bed operating on CO_2 and H_2 at 200°C is demonstrated using a simple tubular membrane reactor module. (author) 5 figs., 1 tab., 9 refs.

29376 (UCRL-CR–115353-95) **The synthesis and characterization of new iron coordination complexes utilizing an asymmetric coordinating chelate ligand.** Watkins, B.E.; Satcher, J.H. Lawrence Livermore National Lab., CA (United States). Mar 1995. 15p. Sponsored by USDOE, Washington, DC (United States). DOE Contract W-7405-ENG-48. Order Number DE96000357. Source: OSTI; NTIS; GPO Dep.

We are investigating the structure/activity relationships of the bacterial enzyme methane monooxygenase, which catalyzes the specific oxidation of methane to methanol. We then utilize this information to design and synthesize inorganic coordination complexes that mimic the function of the native enzyme but are more robust and have higher catalytic site density. We envision these catalysts to be useful in process catalytic reactors in the conversion of methane in natural gas to liquid ethanol.

1003 Properties and Composition

29377 (CONF-950587–4) **Modeling scaleup effects on a small pilot-scale fluidized-bed reactor for fuel ethanol production.** Webb, O.F.; Davison, B.H.; Scott, T.C. Oak Ridge National Lab., TN (United States). [1995]. 14p. Sponsored by USDOE, Washington, DC (United States). DOE Contract AC05-84OR21400. From 17. symposium on biotechnology for fuels and chemicals; Vail, CO (United States); 7-11 May 1995. Order Number DE95017419. Source: OSTI; NTIS; GPO Dep.

Domestic ethanol use and production are presently undergoing significant increases along with planning and construction of new production facilities. Significant efforts are ongoing to reduce ethanol production costs by investigating new inexpensive feedstocks (woody biomass) and by reducing capital and energy costs through process improvements. A key element in the development of advanced bioreactor systems capable of very high conversion rates is the retention of high biocatalyst concentrations within the bioreactor and a reaction environment that ensures intimate contact between substrate and biocatalyst. One very effective method is to use an immobilized biocatalyst that can be placed into a reaction environment that provides effective mass transport, such as a fluidized bed. Mathematical descriptions are needed based on fundamental principles and accepted correlations that describe important physical phenomena. We describe refinements and semiquantitatively extend the predictive model of Petersen and Davison to a multiphase fluidized-bed reactor (FBR) that was scaled-up for ethanol production. Axial concentration profiles were evaluated by solving coupled differential equations for glucose and carbon dioxide. The pilot-scale FBR (2 to 5 m tall, 10.2-cm ID, and 23,000 L $month^{-1}$ capacity) was scaled up from bench-scale reactors (91 to 224 cm long, 2.54 to 3.81 cm ID, and 400 to 2,300 L $month^{-1}$ capacity). Significant improvements in volumetric productivites (50 to 200 g EtOH h^{-1} L^{-1} compared with 40 to 110 for bench-scale experiments and 2 to 10 for reported industrial benchmarks) and good operability were demonstrated.

13 HYDRO ENERGY

1301 Resources and Availability

29378 (DOE/ID–10430(CT)) **U.S. hydropower resource assessment for Connecticut.** Francfort, J.E.; Rinehart, B.N. Fermi National Accelerator Lab., Batavia, IL (United States). Jul 1995. 101p. Sponsored by USDOE, Washington, DC (United States). DOE Contract AC07-94ID13223. Order Number DE96001343. Source: OSTI; NTIS; GPO Dep.

The Department of Energy is developing an estimate of the undeveloped hydro-power potential in the United States. The Hydropower Evaluation Software (HES) is a computer model that was developed by the Idaho National Engineering Laboratory for this purpose. The software measures the undeveloped hydropower resources available in the United States, using uniform criteria for measurement. The software was developed and tested using hydropower information and data provided by the Southwestern Power Administration. It is a menu-driven software program that allows the personal computer user to assign environmental attributes to potential hydropower sites, calculate development suitability factors for each site based on the environmental attributes present, and generate reports based on these suitability factors. This report details the resource assessment results for the State of Connecticut.

29379 (DOE/ID–10430(MA)) **US Hydropower Resource Assessment for Massachusetts.** Francfort, J.E.; Rinehart, B.N. Lockheed Idaho Technologies Co., Idaho Falls, ID (United States). Jul 1995. 200p. Sponsored by USDOE, Washington, DC (United States). DOE Contract AC07-94ID13223. Order Number DE96001330. Source: OSTI; NTIS; GPO Dep.

The Department of Energy is developing an estimate of the undeveloped hydropower potential in the United States. The Hydropower Evaluation Software (HES) is a computer model that was developed by the Idaho National Engineering Laboratory for this purpose. The software measures the undeveloped hydropower resources available in the United States, using uniform criteria for measurement. The software was developed and tested using hydropower information and data provided by the Southwestern Power Administration. It is a menu-driven software program that allows the personal computer user to assign environmental attributes to potential hydropower sites, calculate development suitability factors for each site based on the environmental attributes present, and generate reports based on these suitability factors. This report details the resource assessment results for the Commonwealth of Massachusetts.

29380 (DOE/ID–10430(ME)) **U.S. hydropower resource assessment for Maine.** Francfort, J.E.; Rinehart, B.N. EG and G Idaho, Inc., Idaho Falls, ID (United States). Jul 1995. 462p. Sponsored by USDOE, Washington, DC (United States). DOE Contract AC07-94ID13223. Order Number DE96001324. Source: OSTI; NTIS; GPO Dep.

The Department of Energy is developing an estimate of the undeveloped hydro-power potential in the United States. The Hydropower Evaluation Software (HES) is a computer model that was developed by the Idaho National Engineering Laboratory for this purpose. The software measures the undeveloped hydropower resources available in the United States, using uniform criteria for measurement. The software was developed and tested using hydropower information and data provided by the Southwestern Power Administration. It is a menu-driven software program that allows the personal computer user to assign environmental attributes to potential hydropower sites, calculate development suitability factors for each site based on the environmental attributes present, and generate reports based on these suitability factors. This report details the resource assessment results for the State of Maine.

29381 (DOE/ID–10430(RI)) **US hydropower resource assessment for Rhode Island.** Francfort, J.E.; Rinehart, B.N. Lockheed Idaho Technologies Co., Idaho Falls, ID (United States). Jul 1995. 65p. Sponsored by USDOE, Washington, DC (United States). DOE Contract AC07-94ID13223. Order Number DE96001156. Source: OSTI; NTIS; GPO Dep.

The Department of Energy is developing an estimate of the undeveloped hydropower potential in the United States. The Hydropower Evaluation Software (HES) is a computer model that was developed by the Idaho National Engineering Laboratory for this purpose. The software measures the undeveloped hydropower resources available in the United States, using uniform criteria for measurement. The software was developed and tested using hydropower information and data provided by the Southwestern Power Administration. It is a menu-driven software program that allows the personal computer user to assign environmental attributes to potential hydropower sites, calculate development suitability factors for each site based on the environmental attributes present, and generate reports based on these suitability factors. This report details the resource assessment results for the State of Rhode Island.

1303 Plant Design and Operation

29382 (ELFORSK–93-2) **Efficiency improvements in hydroelectric power plants.** Elforsk AB, Stockholm (Sweden). 1993. 49p. (In Swedish). Order Number DE96703693. Source: OSTI; NTIS.

The economic and environmental potential for hydro power in Sweden is almost completely utilized. Hydroelectric power constitutes roughly half the total electricity production. The present era is characterized by renewal and refurbishment of aging existing plants. With this as a background the Swedish foundation for research in hydroelectric power production (VAST) formed a working group for efficiency improvements. The main task of the working group was to summarize and evaluate relevant areas for efficiency improvements. This report represents the result of the work of the group. The following main subjects are covered in the report: Turbines and waterways; Generators and transformers; Auxiliary equipment; Production optimization; Evaluation methods. This report is restricted to a single power station and is in no way meant to be preemptive. There are naturally other areas such as water planning etc where large benefits could be gained. 15 refs, 39 figs

1306 Environmental Aspects

29383 (DOE/ID–10510(94-95)) **DOE Hydropower Program biennial report 1994–1995 with an updated annotated bibliography.** Rinehart, B.N. (Lockheed Idaho Technologies Co., Idaho Falls, ID (United States)); Francfort, J.E.; Sommers, G.L.; Cada, G.F.; Sale, M.J. Lockheed Idaho Technologies Co., Idaho Falls, ID (United States). May 1995. 71p. Sponsored by USDOE, Washington, DC (United States). DOE Contract AC07-94ID13223. Order Number DE96001331. Source: OSTI; NTIS; INIS; GPO; GPO Dep.

This report, the latest in a series of annual/biennial Hydropower Program reports sponsored by the US Department of Energy, summarizes the research and development and technology transfer activities of fiscal years 1994 and 1995. The report discusses the activities in the four areas of the hydropower program: Environmental Research; Resource Assessment; Research Cost-Shared with Industry; and Technology Transfer. The report also includes an annotated bibliography of reports pertinent to hydropower, written by the staff of the Idaho National Engineering Laboratory, Oak Ridge National Laboratory, Federal and state agencies, cities, metropolitan water districts, irrigation companies, and public and independent utilities. Most reports are available from the National Technical Information Service.

1308 Health and Safety

29384 (ELFORSK–94-17) **Condition assessment of concrete structures in hydroelectric plants.** Wiberg, U. Elforsk AB, Stockholm (Sweden). 1994. 68p. (In Swedish). Order Number DE96703696. Source: OSTI; NTIS.

The state of damage in concrete structures in hydro power stations is described and the current procedures to survey these structures are considered. The need for NDT methods for relative assessment of material quality and degree of deterioration within one structure was identified, as was the need for NDT methods for detection of defects. The investigation provides an overview of the methods for condition assessment that are applicable to concrete testing. The state of the art for NDT techniques based primarily on stress wave propagation, propagation of electromagnetic waves, and dynamic response is presented. The potential of these techniques for the testing of concrete structures is evaluated. The procedures for making an assessment of the general state of a structure are discussed on the basis of local detection of defects using for example stress wave echoes or radar echoes, automated testing procedures such as scanning, and overall structural integrity using for example experimental modal analysis. 19 refs, 18 figs

14 SOLAR ENERGY

29385 (ETDE/JP-mf–96704399) **Report on the results of the New Sunshine Project in fiscal 1993. Solar energy.** New Energy and Industrial Technology Development Organization, Tokyo (Japan). Nov 1994. 552p. (In Japanese). Order Number DE96704399. Source: OSTI; NTIS; Available from New Energy and Industrial Technology Development Organization, Sunshine 60, 30F 1-1, 3-chome, Higashi-Ikebukuro, Toshima-ku, Tokyo, Japan.

This is a report on the results of solar energy related researches made under the fiscal 1993 New Sunshine Project. As for solar energy utilization, research was conducted on practical use of thin-substrate polycrystalline solar cells and thin film solar cells for commercialization of the photovoltaic power generation system. Researches were made on efficiency enhancement to an ultra-high level, evaluation technology and peripheral technology of the power generation system, and demonstration of the utilization system. As to the fundamental study of the photovoltaic power generation, both crystalline silicon and amorphous silicon were being theoretically and experimentally studied. As to solar heat utilization, for practical use of industrial use solar systems, researches were conducted on high-performance insulators, conversion to chemical energy, the freezing and refrigerating system, and the passive solar system. As the solar heat utilization system, also stated were prevailing-type snow melting equipment and retro-fitting technology. Internationally cooperative technology development is also promoted. The paper describes development, operation and control of the large-scale wind power generation system, and the results obtained from data on wind characteristics observation.

29386 (ETDE/JP-mf–96704400) **1993 annual summary of solar energy R and D program.** New Energy and Industrial Technology Development Organization, Tokyo (Japan). Nov 1994. 583p. Order Number DE96704400. Source: OSTI; NTIS; Available from New Energy and Industrial Technology Development Organization, Sunshine 60, 30F 1-1, 3-chome, Higashi-Ikebukuro, Toshima-ku, Tokyo, Japan.

Study results in FY1993 of the solar energy R and D program in the New Sunshine Project promoted by NEDO are reported. On solar photovoltaic energy conversion, 5 reports on thin substrate polycrystalline solar cells for practical use, 7 reports on fabrication

technology of thin film solar cells for practical use, 5 reports on super-high efficiency solar cells, 4 reports on evaluation systems for photovoltaic power generation systems, 7 reports on peripheral technologies for photovoltaic power systems, 7 reports on photovoltaic energy utilization systems, 9 reports on research and development of photovoltaic power systems, and 6 reports on analysis and evaluation of practical applications of photovoltaic power generation systems are included. On utilization technologies of solar thermal energy, 9 reports on utilization technologies of solar thermal systems for industrial use and 4 reports on large-scale wind energy conversion systems are included. Activities on international cooperation are also reported. 65 refs., 396 figs., 90 tabs.

1401 Resources and Availability

Refer also to citation(s) 29393, 29966

1403 Economic, Industrial, and Business Aspects

Refer also to citation(s) 29400, 29857

1405 Solar Energy Conversion

29387 (DOE/ER/75755–T1) **Living Systems Energy Module.** New York Zoological Society, NY (United States). 26 Sep 1995. 150p. Sponsored by USDOE, Washington, DC (United States). DOE Contract FG02-92ER75755. Order Number DE95017794. Source: OSTI; NTIS; GPO Dep.

The Living Systems Energy Module, renamed Voyage from the Sun, is a twenty-lesson curriculum designed to introduce students to the major ways in which energy is important in living systems. Voyage from the Sun tells the story of energy, describing its solar origins, how it is incorporated into living terrestrial systems through photosynthesis, how it flows from plants to herbivorous animals, and from herbivores to carnivores. A significant part of the unit is devoted to examining how humans use energy, and how human impact on natural habitats affects ecosystems. As students proceed through the unit, they read chapters of Voyage from the Sun, a comic book that describes the flow of energy in story form (Appendix A). During the course of the unit, an "Energy Pyramid" is erected in the classroom. This three-dimensional structure serves as a classroom exhibit, reminding students daily of the importance of energy and of the fragile nature of our living planet. Interactive activities teach students about adaptations that allow plants and animals to acquire, to use and to conserve energy. A complete list of curricular materials and copies of all activity sheets appear in Appendix B.

29388 (DOE/OR/21400–T494) **Plasma analysis and diagnostics for high efficiency amorphous solar cell production. Final report.** Klepper, C.C. Oak Ridge National Lab., TN (United States). 21 Dec 1994. 3p. Sponsored by USDOE, Washington, DC (United States). DOE Contract AC05-84OR21400. Order Number DE96000675. Source: OSTI; NTIS; GPO Dep.

This is a project that sought to improve the amorphous silicon-germanium (SiGe) thin film deposition process in the production of solar cells. To accomplish this, the electron cyclotron resonance (ECR) plasma discharge, employed for the thin film deposition, was modified. Changes in the parameters of the plasma were monitored with diagnostic techniques, similar to those used in fusion plasma studies. That was the primary contribution from ORNL. Only one phase was contained in the statement of work, with the following tasks: (1) Develop a detailed program for plasma characterization. (2) Carry-out plasma modeling and analysis to support deposition systems design. (3) Operate experimental deposition systems for the purpose of plasma characterization. (4) Analyze data. (5) Modify deposition as directed by measurements. (6) This final report, which was deemed to be the only deliverable of this small project. And while the modified ECR discharge did not show measurable improvement of the conditions relevant to the deposition process, much was learned about the plasma parameters in the process. Some ideas on alternative designs are being discuss and funding options for testing such designed are being sought.

29389 (ETDE/CH-mf–95795488, pp. 13) **Thin crystalline silicon solar cells.** Kiess, H. (Paul Scherrer Inst. (PSI), Villigen (Switzerland)); Birbaumer, H.; Curtis, B.J.; Gruetzmacher, D.; Mezzacasa, T.; Morf, R.; Rehwald, W.; Hegedues, F.; Glunz, S. [1995]. 82p. In *Paul Scherrer Institut annual report 1994. Annex III B: PSI applied solid state physics.* Order Number DE95795488. Source: OSTI; NTIS.

In order to boost the efficiency of thin crystalline silicon solar cells, light trapping must be applied. Light trapping, realised by diffraction gratings on the rear side of the cells, requires 10 nm thin oxides which must have extremely good passivation properties to prevent surface recombination and hence a decrease of the short circuit current and of the open circuit voltage. Cells with thin oxides showed open circuit voltages as high as 700 mV depending on the preparation process. However, grating fabrication still increases surface recombination. (author) 2 figs., 1 ref.

29390 (ETDE/CH-mf–95795488, pp. 14) **Capacitive open-circuit voltage measurements for controlling solar-cell processing.** Birbaumer, H. (Paul Scherrer Inst. (PSI), Villigen (Switzerland)); Delley, B.; Kiess, H.; Rehwald, W.; Schnidrig, A. [1995]. 82p. In *Paul Scherrer Institut annual report 1994. Annex III B: PSI applied solid state physics.* Order Number DE95795488. Source: OSTI; NTIS.

By measuring the open-circuit voltage of solar cells capacitively between fabrication steps, i.e. before the cell has been finished, sources of contamination and deterioration of the passivation properties of the oxides may be detected at an early stage. It also permits the study of the temporal behaviour of open-circuit voltage decay and the properties of the oxide-semiconductor interface. (author) 2 figs., 1 ref.

29391 (ETDE/CH-mf–95795488, pp. 15) **Simplified fabrication of highly efficient crystalline silicon solar cells.** Kiess, H. (Paul Scherrer Inst. (PSI), Villigen (Switzerland)); Baechle, D.; Birbaumer, H.; Glaus, F.; Gruetzmacher, D.; Mezzacasa, T.; Morf, R.; Rehwald, W. [1995]. 82p. In *Paul Scherrer Institut annual report 1994. Annex III B: PSI applied solid state physics.* Order Number DE95795488. Source: OSTI; NTIS.

The most advanced silicon solar cells reported in the literature, having 20 to 23% efficiency, require about 35 fabrication steps. Since a high number of steps is expected to result in high production costs, our aim was to reduce these costs by achieving a comparable efficiency of about 20% at half of the above number of fabrication steps. We succeeded in producing cells with only 16 fabrication steps having efficiencies between 17 and 19.5%, depending on the quality of light trapping. (author) 2 figs., 1 tab., 1 ref.

29392 (ETDE/CH-mf–95795488, pp. 17) **Low thermal budget process for Si solar cells.** Gruetzmacher, D. (Paul Scherrer Inst. (PSI), Villigen (Switzerland)); Kiess, H.; Mezzacasa, T.; Rehwald, W.; Schaeffler, F.; Glunz, S.; Krueger, D. [1995]. 82p. In *Paul Scherrer Institut annual report 1994. Annex III B: PSI applied solid state physics.* Order Number DE95795488. Source: OSTI; NTIS.

The replacement of Si wafers by low cost glass substrates for thin film silicon solar cells requires low temperature processing. Sb doped Si emitter layers have been deposited by MBE at 450°C on Si substrates. The surface passivation was achieved by a LPCVD oxide layer deposited at 600°C and subsequently baked at 800°C. Using this low temperature process, solar cells with an efficiency of 17% have been fabricated. (author) 2 figs.

29393 (KRC–91G-J07) **Applications Study for PV Generation of Remote Islands.** Jee, P.S. (Korea Electric Power Corp. (KEPCO), Taejon (Korea, Republic of). Research Center); Eum, Y.C.; Lee, C.W.; Kim, J.J.; Im, H.C.; Song, Y.C.; Hwang, I.H.; Park, K.K.; Chung, M.W.; Song, J.S.; Jeon, H.S.; Yoo, K.J.; Yoo, C.J.; Kim, H.W.; Lee, J.T.; KKorea Electric Power Corp. (KEPCO), Taejon (Korea, Republic of). Research Center. 1993. 210p. (In Korean). Order Number DE96703594. Source: OSTI; NTIS (US Sales Only).

This study aims to the practical realization of PV generation system in an effort to back up the rural electrification project as provided in the national rural electrification and facilitation law using alternative sources of energy in areas of islands with no more than 50 households. It is very important to develop PV generation

system readily available for the remote island communities based on the system performance communities based on the system performance measurement, after the system technologies which cause non-pollution, noiseless and non-fuel consumption have been identified and practically applied.

29394 (NREL/TP–411-8122) **Microstructure of amorphous-silicon-based solar cell materials by small-angle x-ray scattering. Annual subcontract report, 6 April 1994–5 April 1995.** Williamson, D.L. (Colorado School of Mines, Golden, CO (United States)). National Renewable Energy Lab., Golden, CO (United States); Colorado School of Mines, Golden, CO (United States). Aug 1995. 40p. Sponsored by USDOE, Washington, DC (United States). DOE Contract AC36-83CH10093. Order Number DE95009273. Source: OSTI; NTIS; GPO Dep.

The general objective of this research is to provide detailed microstructural information on the amorphous-silicon-based, thin-film materials under development for improved multijunction solar cells. The experimental technique used is small-angle x-ray scattering (SAXS) providing microstructural data on microvoid fractions, sizes, shapes, and their preferred orientations. Other microstructural features such as alloy segregation, hydrogen-rich clusters and alloy short-range order are probed.

29395 (NREL/TP–442-8108) **Progress in amorphous silicon PV technology: An update.** Luft, W. (National Renewable Energy Lab., Golden, CO (United States)); Branz, H.M.; Dalal, V.L.; Hegedus, S.S.; Schiff, E.A. National Renewable Energy Lab., Golden, CO (United States). Jul 1995. 22p. Sponsored by USDOE, Washington, DC (United States). DOE Contract AC36-83CH10093. (CONF-950585–3: 13. NREL photovoltaics program review meeting, Lakewood, CO (United States), 16-19 May 1995). Order Number DE95009242. Source: OSTI; NTIS; GPO Dep.

To reach the 15% stabilized efficiency goal for amorphous silicon (a-Si) modules by the year 2005, the National Renewable Energy Laboratory has established four research teams. The teams – with members from industry, universities, and NREL – have been in operation for 2.5 years now. Consensus has been reached that a triple-junction a-Si structure is needed to reach the efficiency goal. Performance parameter goals for the overall structure and the three component cells have been formulated. All four teams have generated their own development plans. Individual team progress relative to the plans is reported.

1406 Photovoltaic Power Systems

Refer also to citation(s) 29393, 29826, 29882

29396 (ELFORSK–94-15) **Solar cells integrated in buildings. IEA project PV in Buildings. Annual report 1994.** Perers, B.; Spante, L.; Tunell, G.; Andersson, Mats; Holmstroem, S. Elforsk AB, Stockholm (Sweden). 1994. 73p. (In Swedish). Order Number DE96703697. Source: OSTI; NTIS.

This report presents the Swedish work performed in the IEA Solar Heating and Cooling Programme, Task 16 'PV in Buildings' during 1994. In Sweden, two new grid-connected systems have been taken into operation. In April a 4.4 kW system was installed on the south facade of the new museum at Haernoesand. The system has operated without any problems except for shadowing from a near-by forest. During summer, the 'PV-roof' at Aelvkarleby has been provided with a new roof-integrated PV-system with a peak power of 1.3 kW. The 13 frameless modules (laminates) have been glued directly on top of a standard corrugated metal roofing. The new system has a notably better performance than the old one. Other activities during 1994 include a final evaluation of the stand-alone system on Huvudskaer, data monitoring and evaluation of the hybrid system (PV, wind, diesel) at Bjoerklaangsberg, and evaluation work on the Stockholm Energi 10 kW system. Initial studies on reflectors for PV-systems have also been performed, as well as a market and potential study. The main results from the studies are: The PV-systems of today are very reliable and have a long life. The main problem in stand-alone systems is the life-time of the batteries. For grid-connected systems most of the problems come from the inverters, that often have low availability. Simple and reliable mounting methods and cable connectors have to be developed in order to make PV-systems more cost effective. During autumn 1994 a discussion has started to begin an investigation to identify cost-effective niche markets within the utility area in Sweden. 4 refs, 55 figs

29397 (ETDE/CH-mf–95795488, pp. 16) **Integrating photovoltaic cells into facade and roof elements.** Kuse, D. (Paul Scherrer Inst. (PSI), Villigen (Switzerland)); Durisch, W.; Kiess, H. [1995]. 82p. In *Paul Scherrer Institut annual report 1994. Annex III B: PSI applied solid state physics.* Order Number DE95795488. Source: OSTI; NTIS.

Two types of photovoltaic panels based on metal-polyethylene-metal laminates as substrates have been demonstrated. One of them uses crystalline silicon solar cells on ALUCOBOND, a commercial cladding material for buildings. The other one incorporates amorphous silicon cells on stainless steel from USSC as one of the metal sheets in the laminate. (author) 2 figs.

29398 (NEDO-P–9426) **Survey for making a data book related to new energy technical development (examples of solar cells).** New Energy and Industrial Technology Development Organization, Tokyo (Japan). Mar 1995. 216p. (In Japanese). Order Number DE96704391. Source: OSTI; NTIS; Available from New Energy and Industrial Technology Development Organization, Sunshine 60, 30F 1-1, 3-chome, Higashi-Ikebukuro, Toshima-ku, Tokyo, Japan.

The paper aggregately collects, systematizes data on the photovoltaic power generation system and prepares a data book related to the photovoltaic power generation. Fields and subjects for data collection are as follows: listing of photovoltaic power generation systems, significance of the photovoltaic power generation system, the status of the solar cell market, policies overseas and in Japan of the photovoltaic power generation system, financial support for installation of the photovoltaic power generation system, comments from installers on the photovoltaic power generation system, flow of installation of the photovoltaic power generation system, listing of windows of photovoltaic power generation related enterprises, etc. Concerning the photovoltaic power generation system, the introduction is worldwidely increasing, and actions to the photovoltaic power generation system are quick taken overseas and in Japan. Therefore, most up-to-date data on the photovoltaic power generation system become old at once, and it is necessary to construct a system to aggregately collect information on the moves in the world. It is necessary not only to renew the data every year, but to enhance accuracy of the data and make them richer.

29399 (NEDO-P–9427) **Survey for making a data book related to new energy technical development (examples of the photovoltaic power generation).** New Energy and Industrial Technology Development Organization, Tokyo (Japan). Mar 1995. 468p. (In Japanese). Order Number DE96704390. Source: OSTI; NTIS; Available from New Energy and Industrial Technology Development Organization, Sunshine 60, 30F 1-1, 3-chome, Higashi-Ikebukuro, Toshima-ku, Tokyo, Japan.

The paper deals with examples of application of solar cells and examples of introduction of the photovoltaic power generation system, classifies them by use, and makes a book of photographs of the examples. As to products applied with solar cells overseas and in Japan, a photograph of the product, the solar cell power generation capacity, and the commercialization status constitute one format per product. As to the photovoltaic power generation system, a photograph of system installation, location, power generation capacity, system type, the solar cell used, owner, and the year of installation constitute one format per system. Fields of application where the use of solar cells are advancing are the following 15 fields: commercial/residential appliances, road/traffic, railroad, general industries, housing-related products, automobiles, agriculture, fishery, ocean development, disaster prevention/safety, amenity, medical care, building, facilities, and environmental improvement. Examples of photographs prepared are 411. The number of products applied with solar cells and the photovoltaic power generation is increasing, backed up by worldwide eagerness for the introduction. As to examples overseas, in particular, there are a great deal to learn such as new fields of application and novel design.

29400 (ORNL–6827) **The integration of renewable energy sources into electric power transmission systems.** Barnes, P.R. (Oak Ridge National Lab., TN (United States)); Dykas, W.P.; Kirby, B.J.; Purucker, S.L.; Lawler, J.S. Oak Ridge National Lab., TN (United States). Jul 1995. 117p. Sponsored by USDOE, Washington, DC (United States). DOE Contract AC05-84OR21400. Order Number DE96000882. Source: OSTI; NTIS; GPO Dep.

Renewable energy technologies such as photovoltaics, solar thermal power plants, and wind turbines are nonconventional, environmentally attractive sources of energy that can be considered for electric power generation. Many of the areas with abundant renewable energy resources (very sunny or windy areas) are far removed from major load centers. Although electrical power can be transmitted over long distances of many hundreds of miles through high-voltage transmission lines, power transmission systems often operate near their limits with little excess capacity for new generation sources. This study assesses the available capacity of transmission systems in designated abundant renewable energy resource regions and identifies the requirements for high-capacity plant integration in selected cases. In general, about 50 MW of power from renewable sources can be integrated into existing transmission systems to supply local loads without transmission upgrades beyond the construction of a substation to connect to the grid. Except in the Southwest, significant investment to strengthen transmission systems will be required to support the development of high-capacity renewable sources of 1000 MW or greater in areas remote from major load centers. Cost estimates for new transmission facilities to integrate and dispatch some of these high-capacity renewable sources ranged from several million dollars to approximately one billion dollars, with the latter figure an increase in total investment of 35%, assuming that the renewable source is the only user of the transmission facility.

29401 (SAND–95-2078C) **Analysis techniques used on field degraded photovoltaic modules.** Hund, T.D.; King, D.L. Sandia National Labs., Albuquerque, NM (United States). [1995]. 12p. Sponsored by USDOE, Washington, DC (United States). DOE Contract AC04-94AL85000. (CONF-9509187–1: Workshop on photovoltaic performance and reliability, Golden, CO (United States), 7-8 Sep 1995). Order Number DE95017887. Source: OSTI; NTIS; GPO Dep.

Sandia National Laboratory's PV System Components Department performs comprehensive failure analysis of photovoltaic modules after extended field exposure at various sites around the world. A full spectrum of analytical techniques are used to help identify the causes of degradation. The techniques are used to make solder fatigue life predictions for PV concentrator modules, identify cell damage or current mismatch, and measure the adhesive strength of the module encapsulant.

1407 Solar Thermal Power Systems

Refer also to citation(s) 29857, 30333

1409 Solar Thermal Utilization

Refer also to citation(s) 29809, 30249

29402 (CONF-890351–, pp. 251-257) **Central solar heating plants with seasonal storage.** Breger, D.S.; Sunderland, J.E. US-DOE Assistant Secretary for Conservation and Renewable Energy, Washington, DC (United States). Office of Energy Management; Pacific Northwest Lab., Richland, WA (United States); Oak Ridge National Lab., TN (United States). Mar 1989. From Thermal energy storage program review; New Orleans, LA (United States); 15-17 Mar 1989. In *U.S. Department of Energy thermal energy storage research activities review: 1989 Proceedings.* 357p. Order Number DE95016394. Source: OSTI; NTIS; GPO Dep.

The University of Massachusetts has recently started a two year effort to identify and design a significant Central Solar Heating Plant with Seasonal Storage (CSHPSS) in Massachusetts. The work is closely associated with the U.S. participation in the International Energy Agency (IEA) Task on CSHPSS. The University is working closely with the Commonwealth of Massachusetts to assist in identifying State facilities as potential sites and to explore and secure State support which will be essential for product development after the design phase. Currently, the primary site is the University of Massachusetts, Amherst campus with particular interest in several large buildings which are funded for construction over the next 4-5 years. Seasonal thermal energy storage will utilize one of several geological formations.

29403 (ETDE/CH-mf–95787322, pp. 35-37) **Computational fluid dynamics simulation of high-temperature solar chemical reactors.** Meier, A. (Paul Scherrer Inst. (PSI), Villigen (Switzerland)). Paul Scherrer Inst. (PSI), Villigen (Switzerland). 1995. In *Paul Scherrer Institut annual report 1994. Annex V: PSI general energy technology newsletter 1994.* 123p. Source: OSTI; NTIS.

The general-purpose computational fluid dynamics (CFD) code CFDS-FLOW3D is used to simulate the fluid-particle flow and heat transfer phenomena in high-temperature solar chemical reactors. Three different prototype reactors with complex three-dimensional geometries are investigated. The influence of various input parameters on the reactor performance is studied. Examples of results of the CFD calculations are presented. (author) 3 figs., 6 refs.

29404 (ETDE/CH-mf–95787322, pp. 38-42) **Kinetic investigations on solar-driven thermochemical cycles with metal oxides to produce hydrogen from water.** Kuhn, P. (Paul Scherrer Inst. (PSI), Villigen (Switzerland)); Ehrensberger, K.; Frei, A.; Ganz, J.; Steiner, E.; Nueesch, P.; Oswald, H.R. Paul Scherrer Inst. (PSI), Villigen (Switzerland). 1995. In *Paul Scherrer Institut annual report 1994. Annex V: PSI general energy technology newsletter 1994.* 123p. Source: OSTI; NTIS.

The objective of present solar chemistry research activities at the Paul Scherrer Institute in collaboration with the University of Zurich is to demonstrate the feasibility of a solar-driven two-step thermochemical cycle to produce hydrogen with mixed iron oxide reaction systems, such as $(Fe_{1-x}Mn_x)_3O_4/(Fe_{1-x}Mn_x)_{1-y}O$, applying the direct absorption particle cloud receiver/reactor principle. Various experimental techniques have been established to study the kinetics of the solar reduction process. The results validate the influence of different parameters on the course of the reaction. For the first time we were able to produce hydrogen by splitting water with solar reduced iron manganese oxide. (author) 6 figs., 1 tab., 14 refs.

29405 (ETDE/CH-mf–95787322, pp. 47-50) **Simultaneous measurement of temperature, emissivity, and irradiance of surfaces irradiated in a solar furnace.** Tschudi, H.R. (Paul Scherrer Inst. (PSI), Villigen (Switzerland)); Schubnell, M.; Mueller, C. Paul Scherrer Inst. (PSI), Villigen (Switzerland). 1995. In *Paul Scherrer Institut annual report 1994. Annex V: PSI general energy technology newsletter 1994.* 123p. Source: OSTI; NTIS.

Endothermic chemical reactions taking place at temperatures above 700°C are candidates for the utilization of solar energy in highly concentrating solar furnaces. Temperature is a key parameter in this context. Conventional pyrometric temperature determination is hardly practicable since the thermal radiation is mixed with the reflected solar radiation, and a reliable emissivity value must be known. In this paper, we present a method by which the temperature, the irradiance, and the emissivity of an irradiated sample can be measured simultaneously. In this scheme, the spectral emissivity, which necessarily must be known for a radiometric temperature determination, may serve also as a probe for chemical or structural changes. We first outline the computational background of the method. We then present experimental results obtained with a laboratory version in order to test the reliability of the method and first measurements on the solar furnace at PSI. (author) 6 figs., 10 refs.

1410 Solar Collectors and Concentrators

Refer also to citation(s) 31334

1420 Heat Storage

Refer also to citation(s) 29807

1430 Health and Safety

29406 (BNL–62224) **Biomonitoring for the photovoltaics industry.** Bernholc, N.M.; Moskowitz, P.D. Brookhaven National Lab., Upton, NY (United States). Jul 1995. 77p. Sponsored by USDOE, Washington, DC (United States). DOE Contract AC02-76CH00016. Order Number DE96001333. Source: OSTI; NTIS; GPO Dep.

Biomonitoring often is used as a method for estimating the dose to an individual. Therefore, a parameter of measurement, or biomarkers must be identified. The purpose of this paper is to give an overview of biomonitoring protocols for metals used in the photovoltaics industry. Special attention is given to areas that often are skimmed over, to gain insights into some of the problems that may arise when these tasks are carried out. Biological monitoring can be used to determine current human exposures to chemicals, as well as to detect past exposures, and the effects that these exposures may have on human health. It is used in conjunction with environmental monitoring to describe more completely worker's exposures to, and absorption of, chemicals in the workplace. Biological specimens (e.g., blood, hair or urine) are analyzed for chemical agents, metabolites, or for some specific effect on the person (Lowry 1994). Biomonitoring can assess a workers exposure to industrial chemicals by all routes including skin absorption and ingestion. Although the methodology still is in its infancy, in cases where the procedures have been developed, it can be an invaluable component of an ongoing program of industrial hygiene monitoring. Like any technology, there are limitations to its effectiveness because of a lack of knowledge, contamination of specimens, and the introduction of errors.

15 GEOTHERMAL ENERGY

1501 Resources and Availability

Refer also to citation(s) 29415, 29416

29407 (LBL–37200, pp. 96-100) **Prognostic simulation of reinjection-research project geothermal site Neustadt-Glewe/ Germany.** Poppei, J. (Geothermie Neubrandenburg GmbH (Germany)). Lawrence Berkeley Lab., CA (United States). Mar 1995. DOE Contract AC03-76SF00098. (CONF-9503110–: TOUGH 95: transport of unsaturated ground water and heat workshop, Berkeley, CA (United States), 20-22 Mar 1995). In *Proceedings of the TOUGH Workshop '95 Lawrence Berkeley Laboratory, Berkeley, California, March 20–22, 1995.* 380p. Order Number DE95014788. Source: OSTI; NTIS; GPO Dep.

For the first time after political and economical changes in Germany a hydrothermal site was put into operation in December 1994. Due to prevailing conditions extraordinary in Central Europe (reservoir temperature 99°C; 220 g/l salinity) the project Neustadt-Glewe is supported by a comprehensive research program. The wells concerned (a doublet with an internal distance of 1.400 m) open the porous sandstone aquifer with an average thickness of about 53 m in a depth of 2.240m. One point of interest was the pressure and temperature behavior over a period of 10 years considering the fluid viscosity changes due to variable injection temperature. For means of reservoir simulation and prognosing the injection behavior and simulator code TOUGH2 was used.

29408 (LBL–37200, pp. 107-112) **Modeling of hydrothermal circulation applied to active volcanic areas. The case of Vulcano (Italy).** Todesco, M. (Dip. Scienze della Terra, Posa (Italy)). Lawrence Berkeley Lab., CA (United States). Mar 1995. DOE Contract AC03-76SF00098. (CONF-9503110–: TOUGH 95: transport of unsaturated ground water and heat workshop, Berkeley, CA (United States), 20-22 Mar 1995). In *Proceedings of the TOUGH Workshop '95 Lawrence Berkeley Laboratory, Berkeley, California, March 20–22, 1995.* 380p. Order Number DE95014788. Source: OSTI; NTIS; GPO Dep.

Modeling of fluid and heat flows through porous media has been diffusely applied up to date to the study of geothermal reservoirs. Much less has been done to apply the same methodology to the study of active volcanoes and of the associated volcanic hazard. Hydrothermal systems provide direct information on dormant eruptive centers and significant insights on their state of activity and current evolution. For this reason, the evaluation of volcanic hazard is also based on monitoring of hydrothermal activity. Such monitoring, however, provides measurements of surface parameters, such as fluid temperature or composition, that often are only representative of the shallower portion of the system. The interpretation of these data in terms of global functioning of the hydrothermal circulation can therefore be highly misleading. Numerical modeling of hydrothermal activity provides a physical approach to the description of fluid circulation and can contribute to its understanding and to the interpretation of monitoring data. In this work, the TOUGH2 simulator has been applied to study the hydrothermal activity at Vulcano (Italy). Simulations involved an axisymmetric domain heated from below, and focused on the effects of permeability distribution and carbon dioxide. Results are consistent with the present knowledge of the volcanic system and suggest that permeability distribution plays a major role in the evolution of fluid circulation. This parameter should be considered in the interpretation of monitoring data and in the evaluation of volcanic hazard at Vulcano.

1502 Geology and Hydrology of Geothermal Systems

Refer also to citation(s) 29407, 29408, 29415, 29416, 29421, 31361

29409 (LBL–37200, pp. 113-118) **Triple-porosity/ permeability flow in faulted geothermal reservoirs: Two-dimensional effects.** Cesar Suarez Arriaga, M. (Michoacan Univ. & CFE, Mich. (Mexico)); Samaniego Verduzco, F. Lawrence Berkeley Lab., CA (United States). Mar 1995. DOE Contract AC03-76SF00098. (CONF-9503110–: TOUGH 95: transport of unsaturated ground water and heat workshop, Berkeley, CA (United States), 20-22 Mar 1995). In *Proceedings of the TOUGH Workshop '95 Lawrence Berkeley Laboratory, Berkeley, California, March 20–22, 1995.* 380p. Order Number DE95014788. Source: OSTI; NTIS; GPO Dep.

An essential characteristic of some fractured geothermal reservoirs is noticeable when the drilled wells intersect an open fault or macrofracture. Several evidences observed, suggest that the fluid transport into this type of systems, occurs at least in three stages: flow between rock matrix and microfractures, flow between fractures and faults and flow between faults and wells. This pattern flow could define, by analogy to the classical double-porosity model, a triple-porosity, triple-permeability concept. From a mathematical modeling point of view, the non-linearity of the heterogeneous transport processes, occurring with abrupt changes on the petrophysical properties of the rock, makes impossible their exact or analytic solution. To simulate this phenomenon, a detailed two-dimensional geometric model was developed representing the matrix-fracture-fault system. The model was solved numerically using MULKOM with a H_2O=CO_2 equation of state module. This approach helps to understand some real processes involved. Results obtained from this study, exhibit the importance of considering the triple porosity/permeability concept as a dominant mechanism producing, for example, strong pressure gradients between the reservoir and the bottom hole of some wells.

29410 (LBL–37200, pp. 119-130) **Numerical simulation of carbon dioxide effects in geothermal reservoirs.** Moya, S.L. (Instituto de Investigaciones Electricas, Cuernavaca (Mexico)); Iglesias, E.R. Lawrence Berkeley Lab., CA (United States). Mar 1995. DOE Contract AC03-76SF00098. (CONF-9503110–: TOUGH 95: transport of unsaturated ground water and heat workshop, Berkeley, CA (United States), 20-22 Mar 1995). In *Proceedings of the TOUGH Workshop '95 Lawrence Berkeley Laboratory, Berkeley, California, March 20–22, 1995.* 380p. Order Number DE95014788. Source: OSTI; NTIS; GPO Dep.

We developed and coded a new equation of state (EOS) for water-carbon dioxide mixtures and coupled it to the TOUGH numerical simulator. This EOS is valid up to 350°C and 500 bar. Unlike previous thermodynamical models, it rigorously considers the non-ideal behavior of both components in the gaseous mixture and formally includes the effect of the compressibility of the liquid phase. We refer to the coupling of this EOS with TOUGH as

TOUGH-DIOX. To complement this enhancement of TOUGH, we added indexed output files for easy selection and interpretation of results. We validated TOUGH-DIOX against published results. Furthermore we used TOUGH-DIOX to explore and compare mass and energy inflow performance relationships of geothermal wells with/without carbon dioxide (CO_2). Our results include the effects of a broad range of fluid and formation properties, initial conditions and history of reservoir production. This work contributes with generalized dimensionless inflow performance relationships appropriate for geothermal use.

29411 (LBL–37200, pp. 245-251) **Modeling the response of the geothermal system at Lihir Island, Papua New Guinea to mine dewatering.** Menzies, A.J. (GeothermEx, Inc., Richmond, CA (United States)); Forth, J.L. Lawrence Berkeley Lab., CA (United States). Mar 1995. DOE Contract AC03-76SF00098. (CONF-9503110–: TOUGH 95: transport of unsaturated ground water and heat workshop, Berkeley, CA (United States), 20-22 Mar 1995). In *Proceedings of the TOUGH Workshop '95 Lawrence Berkeley Laboratory, Berkeley, California, March 20–22, 1995.* 380p. Order Number DE95014788. Source: OSTI; NTIS; GPO Dep.

Lihir Gold, Ltd., with RTZ Corporation, Niugini Mining Ltd. and the Government of Papua New Guinea as major shareholders, plans to mine two contiguous gold orebodies located in the Luise Caldera, Lihir Island, Papua New Guinea. Niugini Mining Ltd. first discovered the deposit, which is believed to be the largest undeveloped gold deposit in the world, in 1982 and detailed exploration was later conducted by Kennecott Corporation (an RTZ subsidiary) who also prepared the plan for mining the deposit. The gold was deposited in the caldera breccias by rising hot fluids from a still active geothermal system to form the orebody which is to be mined in a 2 km x 1.5 km open pit that will ultimately reach a depth of about 220 m below sea level.

29412 (LBL–37611) **Automatic history matching of geothermal field performance.** Finsterle, S.; Pruess, K¿. Lawrence Berkeley Lab., CA (United States). Aug 1995. 7p. Sponsored by USDOE, Washington, DC (United States). DOE Contract AC03-76SF00098. (CONF-951176–1: 17. New Zealand geothermal workshop: human resources in geothermal development, Auckland (New Zealand), 8-10 Nov 1995). Order Number DE96001121. Source: OSTI; NTIS; GPO Dep.

We have developed inverse modeling capabilities for the multiphase multicomponent numerical simulator TOUGH2 to facilitate automatic history matching, and parameter estimation based on data obtained during exploitation of Geothermal fields. The ITOUGH2 code allows one to estimate TOUGH2 input parameters based on any type of observation for which a corresponding TOUGH2 output can be calculated. Furthermore, a detailed residual and error analysis is performed, and the uncertainty of model predictions can be evaluated. This paper focuses on the solution of the inverse; problem, i.e. the determination of model-related parameters by automatically calibrating a conceptual model of the Geothermal system against data obtained during field operation. We first describe the modeling, approach used to simulate fluid and heat flow in fractured-porous media. The inverse problem is then formulated, followed by a brief discussion of the optimization algorithm. A sample problem is given to demonstrate the application of the method to Geothermal reservoir data.

29413 (UCRL-JC–121502) **Modeling self-potential data in the Abraham and Meadow-Hatton geothermal systems: The search for upflow zones.** Schima, S. (Lawrence Livermore National Lab., CA (United States)); Wilt, M.; Ross, H. Lawrence Livermore National Lab., CA (United States). Jul 1995. 25p. Sponsored by USDOE, Washington, DC (United States). DOE Contract W-7405-ENG-48. (CONF-951037–3: Annual meeting of the Geothermal Resources Council, Reno, NV (United States), 8-11 Oct 1995). Order Number DE96000088. Source: OSTI; NTIS; GPO Dep.

Computer code SPXCL is a finite difference modeling algorithm that calculates the response of embedded point sources within a rectangular, two-dimensional medium. The code calculates the electrical potential anywhere in the medium from thermal or pressure sources. This code is useful in calculating self-potential measurements that may be used to locate upflow zones in geothermal systems. Beginning in 1991 data on self-potential was collected at Abraham and Meadow-Hatton Hot Springs, two of the largest thermal spring systems in Utah. In this paper, these data were modeled to determine upflow zones and source characteristics using the SPXCL code. The forward solution for fluid and heat flow models and the resulting self-potential anomalies were calculated.

1503 Geothermal Exploration and Exploration Technology

29414 (ETDE/JP-mf–96704395) **Report on fiscal 1992 geothermal development promotion survey data. No.A-1 Mannenyama area (first).** New Energy and Industrial Technology Development Organization, Tokyo (Japan). Mar 1994. 600p. (In Japanese). Order Number DE96704395. Source: OSTI; NTIS; Available from New Energy and Industrial Technology Development Organization, Sunshine 60, 30F 1-1, 3-chome, Higashi-Ikebukuro, Toshima-ku, Tokyo, Japan.

A synthetic analysis was made of the results of the fiscal 1992 survey on geothermal resource existing in the Mannenyama area. The area surveyed is located at the central-west part of Oita prefecture, belonging to an administrative division of Kusu-machi and Kokonoe-cho, Kusu-county, Oita pref. The area surveyed was approximately 280 km^2. As signs of existence of geothermal energy, there are seen hot springs and alteration zones there. In the Takigami district neighboring the south-east part of the area, construction of a geothermal power plant is being planned. From a synthetic consideration of various investigations, the region round the Inomuta sedimentation zone is considered to be a district satisfying conditions for existence of geothermal resource and a promising geothermal district, where Takigami, Otake, Hachoubaru and Okuni are widely included. In the area surveyed this time, the area around Noya-Mizuwaketouge seems to be the most potential for geothermal resource, judging from the alteration status, abnormal mercury concentration, fault state structure and spread of the low resistivity zone. Also in the south and the north-east of the area, geothermal activities can be estimated. 99 refs., 194 figs., 52 tabs.

29415 (ETDE/JP-mf–96704396) **Soil gas survey in Shiratori region, No.C-1 report on the determination of prospective drilling, the ground survey of geothermal development promotion in fiscal 1992.** New Energy and Industrial Technology Development Organization, Tokyo (Japan). Mar 1994. 67p. (In Japanese). Order Number DE96704396. Source: OSTI; NTIS; Available from New Energy and Industrial Technology Development Organization, Sunshine 60, 30F 1-1, 3-chome, Higashi-Ikebukuro, Toshima-ku, Tokyo, Japan.

In the region around Shiratori Hot Spring, Ebino City, Miyazaki Prefecture, the mercury concentration and carbon isotopic ratio were measured in the soil gas to locate the zones where geothermal fluid exists, and distribution of fractures which control the fluid behavior. The survey period was March and April, 1993 with 247 measuring spots. In the region where the mercury concentration is high in the soil gas, the geothermal fluid is judged generally existent along the structure which controls the geothermal activity. The volcanic gas which is a source to heat the geothermal fluid is judged to be ascending in the region where the carbon isotopic ratio is high. In the present survey, regions where both of them were high were extracted as a promising existence zone of geothermal fluid. I.e., the promising zones lie around Shiratori Hot Spring No.1, around KT-4, southerly around N4-ST-2, around 54E-OBN-1–2 and northerly around N4-ST-2. Besides, regions where the mercury concentration and carbon isotopic ratio are both high lie along fractures presumed to be existent northeast of N4-ST-1 and northeast of KT-9 in the direction of NW-SE. It suggests the possible existence of geothermal fluid. 5 refs., 14 figs., 1 tab.

29416 (ETDE/JP-mf–96704397) **Precision gravity exploration in Shiratori region, No.C-1 report on the survey of geothermal structure, the ground survey of geothermal development promotion in fiscal 1992.** New Energy and Industrial Technology Development Organization, Tokyo (Japan). Mar 1994. 105p. (In Japanese). Order Number DE96704397. Source: OSTI;

NTIS; Available from New Energy and Industrial Technology Development Organization, Sunshine 60, 30F 1-1, 3-chome, Higashi-Ikebukuro, Toshima-ku, Tokyo, Japan.

In January and February, 1993, the precision gravity exploration was made in Ebino City, Miyazaki Prefecture to grasp the geothermal structure of Shiratori region, where Kurino lava and Koshikidake lava crop out as old Kirishima volcanic rock, and old/new Shiratori volcanic lava and new Kirishima volcanic lava, respectively. In an area expanding to 16km^2, the gravity exploration was made at 220 spots at measurement intervals of 200m. Upon drawing an equi-gravity diagram, the gravitational basement was structurally presumed by two-dimensional section multi-layer structural analysis and second differential analysis. The anomalous zone where the gravity is lower than −5mgal agrees with the collapse zone based on the NW-SE system geothermal fault. Generally, the basement structure subsides in both northwestern and southeastern parts of detailed survey area, and upheaves in both its northeastern and southwestern parts. On the border to the west of gravitational basement upheaving in the northeastern part of survey area, the gravitational lineament is judged to be a passage of hydrothermal flow. Therefore, there is a possibility that the geothermal reservoir exists along it. It is also judged that other lineaments control the geothermal structure of survey area. 7 refs., 26 figs., 4 tabs.

1505 Economic, Industrial, and Business Aspects

Refer also to citation(s) 29417

1508 Geothermal Power Plants

Refer also to citation(s) 29882

29417 (ETDE/JP-mf–96704402) **Report on demonstration test on small- and medium-size geothermal binary power generation systems (1993).** New Energy and Industrial Technology Development Organization, Tokyo (Japan). Mar 1995. 614p. (In Japanese). Order Number DE96704402. Source: OSTI; NTIS; Available from New Energy and Industrial Technology Development Organization, Sunshine 60, 30F 1-1, 3-chome, Higashi-Ikebukuro, Toshima-ku, Tokyo, Japan.

With relation to the geothermal binary power generation system, investigations were made on evaluation of economic efficiency, basic commercialization/introduction study, check and review of the power system, present scale prevention measures, etc. As for evaluation of economic efficiency, revision of the evaluation system was carried out, and power generation unit prices were trially calculated in cases of 100 kW class and 500 kW class remote islands, hotels, etc. As to basic commercialization/introduction research, studies were conducted on the assistance system in Japan, present geothermal binary power generation and assistance system in the U.S., etc. Concerning check and review of the power system, discussions were made on the 100kW class geothermal binary power generation system in terms of items necessary for check and review, study results and problems arising toward spread and promotion of the system. For spread and promotion, studies were also carried out on cost reduction of equipment production, increase of performance, simplification of operation/maintenance, relaxation of regulations, etc. For scale prevention measures, main literature/data on this subject were investigated and scale prevention technology was arranged. 199 refs., 73 figs., 38 tabs.

29418 (LA-UR–95-2487) **Using a hot dry rock geothermal reservoir for load following.** Brown, D.W.; Duteau, R.J. Los Alamos National Lab., NM (United States). [1995]. 3p. Sponsored by USDOE, Washington, DC (United States). DOE Contract W-7405-ENG-36. (CONF-950125–2: 20. annual workshop on geothermal reservoir engineering, Stanford, CA (United States), 24-26 Jan 1995). Order Number DE95016996. Source: OSTI; NTIS; INIS; GPO Dep.

Field measurements and modeling have shown the potential for using a Hot Dry Rock (HDR) geothermal reservoir for electric load following: either with Power-Peaking from a base-load operating condition, or for Pumped Storage of off-peak electric energy with a very significant thermal augmentation of the stored mechanical energy during periods of power production. For the base-load with power- peaking mode of operation, and HDR reservoir appears capable of producing over twice its nominal power output for short – 2 to 4 hour – periods of time. In this mode of operation, the reservoir normally would be produced under a high-backpressure condition with the HDR reservoir region near the production well highly inflated. Upon demand, the production backpressure would be sharply reduced, surging the production flow. The analytical tool used in these investigations has been the transient finite element model of the an HDR reservoir called GEOCRACK, which is being developed by Professor Dan Swenson and his students at Kansas State University. This discrete-element representation of a jointed rock mass has recently been validated for transient operations using the set of cyclic reservoir operating data obtained at the end of the LTFT.

1509 Geothermal Engineering

Refer also to citation(s) 29407, 29417

29419 (LBL–37200, pp. 77-83) **Vapor pressure lowering effects due to salinity and suction pressure in the depletion of vapor-dominated geothermal reservoirs.** Battistelli, A. (Aquater S.p.A., Pisa (Italy)); Calore, C.; Pruess, K. Lawrence Berkeley Lab., CA (United States). Mar 1995. DOE Contract AC03-76SF00098. (CONF-9503110–: TOUGH 95: transport of unsaturated ground water and heat workshop, Berkeley, CA (United States), 20-22 Mar 1995). In *Proceedings of the TOUGH Workshop '95 Lawrence Berkeley Laboratory, Berkeley, California, March 20–22, 1995.* 380p. Order Number DE95014788. Source: OSTI; NTIS; GPO Dep.

The equation-of-state module able to handle saline brines with non-condensible gas, developed for the TOUGH2 simulator, has been improved to include vapor pressure lowering (VPL) due to suction pressure as represented by Kelvin's equation. In this equation the effects of salt are considered whereas those of non-condensible gas have currently been neglected. Numerical simulations of fluid production from tight matrix blocks have been performed to evaluate the impact of VPL effects due to salinity and suction pressure on the depletion behaviour of vapor-dominated geothermal reservoirs. Previous studies performed neglected VPL due to suction pressure showed that for initial NaCl mass fractions above threshold values, "sealing" of the block occurs and large amounts of liquid fluid may not be recovered. On the other hand, below the threshold value the matrix block dries out due to fluid production. The inclusion of VPL due to suction pressure does not allow complete vaporization of the liquid phase. As a result, the threshold NaCl concentration above which sealing of the matrix block occurs is increased. Above the "critical" NaCl concentration, block depletion behaviour with and without the VPL due to suction pressure is almost identical, as liquid phase saturation remains high even after long production times. As the VPL due to suction pressure depends mainly on capillary pressure, the shape of capillary pressure functions used in numerical simulations is important in determining VPL effects on block depletion.

29420 (LBL–37200, pp. 84-89) **Coupling of the reservoir simulator TOUGH and the wellbore simulator WFSA.** Hadgu, T. (Lawrence Berkeley Laboratory, Berkeley, CA (United States)); Zimmerman, R.W.; Bodvarsson. Lawrence Berkeley Lab., CA (United States). Mar 1995. DOE Contract AC03-76SF00098. (CONF-9503110–: TOUGH 95: transport of unsaturated ground water and heat workshop, Berkeley, CA (United States), 20-22 Mar 1995). In *Proceedings of the TOUGH Workshop '95 Lawrence Berkeley Laboratory, Berkeley, California, March 20–22, 1995.* 380p. Order Number DE95014788. Source: OSTI; NTIS; GPO Dep.

The reservoir simulator TOUGH and the wellbore simulator WFSA have been coupled, so as to allow simultaneous modeling of the flow of geothermal brine in the reservoir as well as in the wellbore. A new module, COUPLE, allows WFSA to be called as a subroutine by TOUGH. The mass flowrate computed by WFSA now serves as a source/sink term for the TOUGH wellblocks. Sample problems are given to illustrate the use of the coupled codes. One of these problems compares the results of the new simulation method to those obtained using the deliverability option in TOUGH.

The coupled computing procedure is shown to simulate more accurately the behavior of a geothermal reservoir under exploitation.

29421 (LBL–37200, pp. 101-106) **Simulation of the Heber geothermal field, a TOUGH2/PC application.** Antunez, E. (Lawrence Berkeley Laboratory, Berkeley, CA (United States)); Lippmann, M.; Ali Khan, M. Lawrence Berkeley Lab., CA (United States). Mar 1995. DOE Contract AC03-76SF00098. (CONF-9503110–: TOUGH 95: transport of unsaturated ground water and heat workshop, Berkeley, CA (United States), 20-22 Mar 1995). In *Proceedings of the TOUGH Workshop '95 Lawrence Berkeley Laboratory, Berkeley, California, March 20–22, 1995.* 380p. Order Number DE95014788. Source: OSTI; NTIS; GPO Dep.

A numerical simulation model for the Heber geothermal field in southern California is being developed under a technology transfer agreement between the Department of Energy/LBL and the California Department of Conservation, Division of Oil, Gas, and Geothermal Resources (Division). The two objectives of the cooperation are: (1) to train Division personnel in the use of the TOUGH2/PC computer code; and (2) to develop a module compatible with TOUGH2 to investigate the effects of production/injection operations on the ground surface subsidence-rebound phenomenon observed in the field. The compaction of the rock formation will be handled assuming an elastic behavior of the rock-fluid system. Considered will be changes in pore volume and in-grid block dimensions, as well as, the process by which the change in formation volume is transmitted to the surface (vertical deformation; subsidence and rebound).

1510 Direct Energy Utilization

29422 (DOE–13049-5) **Ground-source heat pump case studies and utility programs.** Lienau, P.J.; Boyd, T.L.; Rogers, R.L. Oregon Inst. of Tech., Klamath Falls, OR (United States). Geo-Heat Center. Apr 1995. 95p. Sponsored by USDOE, Washington, DC (United States). DOE Contract FG07-90ID13040. Order Number DE95016906. Source: OSTI; NTIS; GPO Dep.

Ground-source heat pump systems are one of the promising new energy technologies that has shown rapid increase in usage over the past ten years in the United States. These systems offer substantial benefits to consumers and utilities in energy (kWh) and demand (kW) savings. The purpose of this study was to determine what existing monitored data was available mainly from electric utilities on heat pump performance, energy savings and demand reduction for residential, school and commercial building applications. In order to verify the performance, information was collected for 253 case studies from mainly utilities throughout the United States. The case studies were compiled into a database. The database was organized into general information, system information, ground system information, system performance, and additional information. Information was developed on the status of demand-side management of ground-source heat pump programs for about 60 electric utility and rural electric cooperatives on marketing, incentive programs, barriers to market penetration, number units installed in service area, and benefits.

29423 (LA–12809-Pt.1) **The furnace in the basement: Part 1, The early days of the Hot Dry Rock Geothermal Energy Program, 1970–1973.** Smith, M.C. Los Alamos National Lab., NM (United States). Sep 1995. 215p. Sponsored by USDOE, Washington, DC (United States). DOE Contract W-7405-ENG-36. Order Number DE96000060. Source: OSTI; NTIS; GPO Dep.

This report presents the descriptions of the background information and formation of the Los Alamos Scientific Laboratory Geothermal Energy Group. It discusses the organizational, financial, political, public-relations,geologic, hydrologic, physical, and mechanical problems encountered by the group during the period 1970–1973. It reports the failures as well as the successes of this essential first stage in the development of hot dry rock geothermal energy systems.

1520 Geothermal Data and Theory

Refer also to citation(s) 29415, 31360

17 WIND ENERGY

1701 Resources and Availability (Climatology)

Refer also to citation(s) 29966

1704 Economic, Industrial, and Business Aspects

Refer also to citation(s) 29400

1706 Wind Energy Engineering

Refer also to citation(s) 29882

29424 (NREL/TP–442-6912) **Dynamic stall occurrence on a horizontal axis wind turbine blade.** Shipley, D.E. (Colorado Univ., Boulder, CO (United States). Dept. of Aerospace Engineering Sciences); Miller, M.S.; Robinson, M.C. National Renewable Energy Lab., Golden, CO (United States). Jul 1995. 7p. Sponsored by USDOE, Washington, DC (United States). DOE Contract AC36-83CH10093. (CONF-950116–8: 1995 American Society of Mechanical Engineers (ASME) energy sources technology conference and exhibition, Houston, TX (United States), 29 Jan - 1 feb 1995). Order Number DE95009264. Source: OSTI; NTIS; GPO Dep.

Surface pressure data from the National Renewable Energy Laboratory's "Combined Experiment" were analyzed to provide a statistical representation of dynamic stall occurrence on a downwind horizontal axis wind turbine (HAWT). Over twenty thousand blade rotational cycles were each characterized at four span locations by the maximum leading edge suction pressure and by the azimuth, velocity, and yaw at which it occurred. Peak suction values at least twice that seen in static wind tunnel tests were taken to be indicative of dynamic stall. The occurrence of dynamic stall at all but the inboard station (30% span) shows good quantitative agreement with the theoretical limits on inflow velocity and yaw that should yield dynamic stall. Two hypotheses were developed to explain the discrepancy at 30% span. Estimates are also given for the frequency of dynamic stall occurrence on upwind turbines. Operational regimes were identified which minimize the occurrence of dynamic stall events.

29425 (NREL/TP–442-7391) **Analysis and test results for a two-bladed, passive cycle pitch, horizontal-axis wind turbine in free and controlled yaw.** Holenemser, K.H. (Washington Univ., St. Louis, MO (United States)). National Renewable Energy Lab., Golden, CO (United States); Washington Univ., St. Louis, MO (United States). Oct 1995. 90p. Sponsored by USDOE, Washington, DC (United States). DOE Contract AC36-83CH10093. Order Number DE95009291. Source: OSTI; NTIS; GPO Dep.

This report surveys the analysis and tests performed at Washington University in St. Louis, Missouri, on a horizontal-axis, two-laded wind turbine with teeter hub. The introduction is a brief account of results obtained during the 5-year period ending December 1985. The wind tunnel model and the test turbine (7.6 m [25 ft.] in diameter) at Washington University's Tyson Research Center had a 67° delta-three angle of the teeter axis. The introduction explains why this configuration was selected and named the passive cycle pitch (PCP) wind turbine. Through the analysis was not limited to the PCP rotor, all tests, including those done from 1986 to 1994, wee conducted with the same teetered wind rotor. The blades are rather stiff and have only a small elastic coning angle and no precone.

20 FOSSIL-FUELED POWER PLANTS

Refer also to citation(s) 29436

29426 (KRC–90I-J03) **Development of Optimal Boiler Controllers Based on Boiler Parameter Identification(I).** Park, I.S. (Korea Electric Power Corp. (KEPCO), Taejon (Korea, Republic of). Research Center); Ryu, H.W.; Ahn, Y.S.; Chung, C.S.; Yang, H.S.; Seo, J.H.; Kim, Y.C.; Hwang, J.H.; Kong, J.S.; Lee, S.H.; Park, K.C.; Lee, J.M.; Cho, C.H.; Yoo, S.W.; Cho, N.H.;.Korea Electric Power Corp. (KEPCO), Taejon (Korea, Republic of). Research

Center. 1993. 232p. (In Korean). Order Number DE96703610. Source: OSTI; NTIS (US Sales Only).

Traditionally, the control of Boiler in domestic power plants mainly depends on PID control. However, in several foreign countries, analog control schemes have been gradually replaced by digital control schemes, and nowadays modern control techniques come to use. Since such a trend seems to accelerate to improve the efficiency of the controllers, the study on the mathematical modelling of a boiler, which is inherently a nonlinear multivariable system, is indispensably demanded. In this research, We first establish a mathematical model of a boiler-turbine system for the purpose of design and verification of optimal boiler controllers, and obtain the various boiler parameters through the identification process. We also provide basic software for a simulator which can be operated on personal computer. Next, we design highly efficient,optimal controller by applying appropriate modern control techniques in consideration of the physical characteristics of boiler-turbine system. This Research will contribute to technical independence in production of power plant control equipment. (author). 53 refs., fig.

29427 (KRC–91I-J02) **Development of the Advanced Turbine Supervisory Instrument of Power Plants.** Hur, S.K. (Korea Electric Power Corp. (KEPCO), Taejon (Korea, Republic of). Research Center); Ryu, H.W.; Chung, C.K.; Kim, C.S.; Kwark, W.H.; Hwang, H.S.; Son, K.S.; Kwon, W.H.; Kim, S.W.; No, S.B.; Lee, J.H.; Lee, J.W.; Lee, J.Y.; Woo, W.S.; Lee, Y.C.; PaKorea Electric Power Corp. (KEPCO), Taejon (Korea, Republic of). Research Center. 1993. 173p. (In Korean). Order Number DE96703611. Source: OSTI; NTIS (US Sales Only).

In power plants, it is necessary to operate the turbine generator more efficiently and prevent accidents. And it is also necessary to measure the status of operation and inform the operators more quickly. In this project, it is main objective to develop turbine Supervisory Instrument using micro processor in order to meet above necessities.

2001 Power Plants and Power Generation

Refer also to citation(s) 28644, 28662, 28675, 29253, 29254, 29261, 29300, 29301, 29317, 29355, 29359, 29838, 29995, 30293, 30355, 31150

29428 (DOE/MC/27363–5012) **Integrated Gasification Combined Cycle (IGCC) demonstration project, Polk Power Station – Unit No. 1. Annual report, October 1993–September 1994.** Tampa Electric Co., FL (United States). May 1995. 63p. Sponsored by USDOE, Washington, DC (United States). DOE Contract FC21-91MC27363. Order Number DE95009742. Source: OSTI; NTIS; GPO Dep.

This describes the Tampa Electric Company's Polk Power Station Unit 1 (PPS-1) Integrated Gasification Combined Cycle (IGCC) demonstration project which will use a Texaco pressurized, oxygen-blown, entrained-flow coal gasifier to convert approximately 2,300 tons per day of coal (dry basis) coupled with a combined cycle power block to produce a net 250 MW electrical power output. Coal is slurried in water, combined with 95% pure oxygen from an air separation unit, and sent to the gasifier to produce a high temperature, high pressure, medium-Btu syngas with a heat content of about 250 Btu/scf (LHV). The syngas then flows through a high temperature heat recovery unit which cools the syngas prior to its entering the cleanup systems. Molten coal ash flows from the bottom of the high temperature heat recovery unit into a water-filled quench chamber where it solidifies into a marketable slag by-product.

29429 (DOE/MC/30246–4066) **Advanced Turbine Systems Program, Conceptual Design and Product Development. Task 6, System definition and analysis.** Solar Turbines International, San Diego, CA (United States). Apr 1995. 56p. Sponsored by USDOE, Washington, DC (United States). DOE Contract AC21-93MC30246. Order Number DE95009712. Source: OSTI; NTIS; GPO Dep.

The strategy of the ATS program is to develop a new baseline for industrial gas turbine systems for the 21st century, meeting the buying criteria of industrial gas turbine end users, and having growth potential. These criteria guided the Solar ATS Team in selecting the system definition described in this Topical Report. The key to selecting the ATS system definition was meeting or exceeding each technical goal without negatively impacting other commercial goals. Among the most crucial goals are the buying criteria of the industrial gas turbine market. Solar started by preliminarily considering several cycles with the potential to meet ATS program goals. These candidates were initially narrowed based on a qualitative assessment of several factors such as the potential for meeting program goals and for future growth; the probability of successful demonstration within the program's schedule and expected level of funding; and the appropriateness of the cycle in light of end users' buying criteria. A first level Quality Function Deployment (QFD) analysis then translated customer needs into functional requirements, and ensured favorable interaction between concept features. Based on this analysis, Solar selected a recuperated cycle as the best approach to fulfilling both D.O.E. and Solar marketing goals. This report details the design and analysis of the selected engine concept, and explains how advanced features of system components achieve program goals. Estimates of cost, performance, emissions and RAMD (reliability, availability, maintainability, durability) are also documented in this report.

29430 (DOE/PC/91154–T9) **Development of a high-performance coal-fired power generating system with pyrolysis gas and char-fired high temperature furnace (HITAF). Progress report No. 12, September–December 1994.** Foster Wheeler Development Corp., Livingston, NJ (United States). Jun 1995. 28p. Sponsored by USDOE, Washington, DC (United States). DOE Contract AC22-91PC91154. Order Number DE95017738. Source: OSTI; NTIS; GPO Dep.

A concept for an advanced coal-fired combined-cycle power generating system is currently being developed. The first phase of this three-phase program consists of conducting the necessary research and development to define the system, evaluating the economic and technical feasibility of the concept, and preparing an R&D plan to develop the concept further. There are two basic arrangements of our HIPPS cycle. Both are coal-fired combined cycles. One arrangement is the 35% natural gas HIPPS. Coal is converted to fuel gas and char in a pyrolysis process, and these fuels are fired in separate parts of a high temperature advanced furnace (HITAF). The char-fired furnace produces flue gas that is used to heat gas turbine air up to 1400 F. Alloy tubes are used for these tube banks. After leaving the alloy tube banks, the gas turbine air goes through a ceramic air heater where it is heated from 1400 F to 1800 F. The flue gas that goes through the ceramic air heater comes from the combustion of the fuel gas that is produced in the pyrolysis process. This fuel gas is cleaned to remove particulates and alkalies that would corrode and plug a ceramic air heater. The air leaving the ceramic air heater needs to be heated further to achieve the efficiency goal of 47%, and this is done by firing natural gas in the gas turbine combustor. An alternative arrangement of the HIPPS cycle is called the All Coal HIPPS. With this arrangement, the char is used to heat the gas turbine air to 1400 F as before, but instead of then going to a ceramic air heater, the air goes directly to the gas turbine combustor. The fuel gas generated in the pyrolyzer is used as fuel in the gas turbine combustor. In both cycle arrangements, heat is transferred to the steam cycle in the HITAF and a heat recovery steam generator (HRSG).

29431 (DOE/PC/91155–T11) **Coal-fired high performance power generating system. Draft quarterly progress report, January 1–March 31, 1995.** United Technologies Research Center, East Hartford, CT (United States). [1995]. 25p. Sponsored by USDOE, Washington, DC (United States). DOE Contract AC22-92PC91155. Order Number DE96000931. Source: OSTI; NTIS; GPO Dep.

This report covers work carried out under Task 3, Preliminary R and D, under contract DE-AC22-92PC91155, "Engineering Development of a Coal-Fired High Performance Power Generation System" between DOE Pittsburgh Energy Technology Center and United Technologies Research Center. The goals of the program are to develop a coal-fired high performance power generation system (HIPPS) by the year 2000 that is capable of >47% thermal efficiency; NO_x, SO_x and particulates $\leq$ 25% NSPS; cost $\geq$65% of

heat input; all solid wastes benign. A crucial aspect of the authors design is the integration of the gas turbine requirements with the HITAF output and steam cycle requirements. In order to take full advantage of modern highly efficient aeroderivative gas turbines they have carried out a large number of cycle calculations to optimize their commercial plant designs for both greenfield and repowering applications.

29432 (KRC–89G-J05) **Development of Condition Monitoring Techniques of Degradation of the High-Temperature Facilities.** Kim, J.C. (Korea Electric Power Corp. (KEPCO), Taejon (Korea, Republic of). Research Center); Kim, J.Y.; Kim, S.T.; Kim, Y.H.; Bae, B.H.; Moon, H.K.; Lee, H.M.; Yoon, K.B.; Nam, S.H.; Kim, S.C.; Park, J.S. Korea Electric Power Corp. (KEPCO), Taejon (Korea, Republic of). Research Center. 1993. 436p. (In Korean). Order Number DE96703584. Source: OSTI; NTIS (US Sales Only).

High temperature components of fossil power plants suffer from changes of mechanical and electrical properties with long-term usage. The material degradation causes problems in plant integrity and facility safety. Destructive techniques are available for condition monitoring and life assessment of the components. However, these techniques take long time for application. And for some components such as turbines they can not be applied since specimen sampling for destructive testing is impractical. Hence, necessity of developing nondestructive techniques arises. Since most of manufacturers of plant facility in foreign conturies are reluctant in transfering the life assessment technology, this study has been carried out aming at the life assement technology and the life management scheme.

29433 (KRC–91G-J02) **A Study on the Reduction Method and the Analysis of VCB Switching Surge for High Voltage Induction Motors.** Kim, T.S. (Korea Electric Power Corp. (KEPCO), Taejon (Korea, Republic of). Research Center); Kim, G.Y.; Lee, S.C.; Lee, S.H.; Sher, S.K.; Park, M.S.; Lee, E.W.; Chang, S.M.; Chung, T.W.; Lee, M.Y.; Han, S.O.; Kim, I.J.; Kim, J.G.; Lee, S.H.; Chung, J.H.;.Korea Electric Power Corp. (KEPCO), Taejon (Korea, Republic of). Research Center. 1993. 288p. (In Korean). Order Number DE96703587. Source: OSTI; NTIS (US Sales Only).

Motors have been widely used as driving devices in many fields of our lives as the data from America Energy Department shows that 64 percent of the total electrical power of the nation in 1978 was consumed by motors. Motors kept on being developed steadily over the last century since its appearance, but insulation measures from the switching surge has yet to be solved. ABB,MBB,OCB have been used as starting tripping and protecting circuit breaker of high voltage motor in the power plants. But recently the VCB(Vacuum Circuit breaker), which has the advantage of excellent interruption, long life, easy maintenance , compact structure is increasingly used. And newly built the thermal power plants and the hydroelectric power plants are in favor of this kind of VCB and this trend is expected to be continued in the following power plants. VCB, with its big are extinction in switching time produces high switching surge voltage which may cause the breakdown of motor insulation or accelerate winding insulation deterioration. Therefore a new method of surge reduction to appropriate the level for using motors needs to be studied. So, in this study we will examine the switching surge occurrence of the VCB, investigate the effect of the switching surge to motors and power source in transient phenomena. Therefore we would like to develop a method of surge reduction and computer simulation algorithm. From the simulation results of the applying this developed algorithm, we can minimize the impact of surge to the motor and power source. This way we can prevent accident from high voltage motors, prolong the motor life, and contribute to the BIL(Basic Impulse Insulation Level) of insulation of the motor utility system. (author). 91 refs., fig.

29434 (KRC–91G-S05) **Wear and erosion prevention of rotating components in coal fired power plant using plasma spray method.** Kim, J.Y. (Korea Electric Power Corp. (KEPCO), Taejon (Korea, Republic of). Research Center); Kim, J.C.; Kim, S.T.; Kim, U.H.; Bae, B.H.; Kim, K.I. Korea Electric Power Corp. (KEPCO), Taejon (Korea, Republic of). Research Center. 1993. 96p. (In Korean). Order Number DE96703583. Source: OSTI; NTIS (US Sales Only).

The surface treatments on the major metal parts of the power plants are necessary to protect power generating equipment from damages (corrosion, erosion, wear etc.) due to the environmental factors (high pressure, high temperature, wear, sea water, pulverized coal, ash,etc). The major surface treatments are carbunizing, nitriding, PVD (physical vapour deposition), CVD (chemical vapour deposition) plating ion implantation, painting, and thermal spray. The plasma spraying is surface treatment method that the coating is made by impacting molten metal or ceramic on substrate using the high velocity gas jet. It is possible to build up the coating which provides wear resistant, corrosion resistant, oxidation resistant, insulation properties depending upon the composition and type of the coating powder. Also, the method is applicable to the large size equipment and the operating machinery. Therefore, it is possible to maintain power generation equipment economically by the application of plasma spraying method in order to protect the fan and pump among the power generation equipment from various damages by environmental factors. (author). 7 refs., fig

29435 (KRC–93G-S08) **A Study for the stress Analysis of High Temperature Pipe System and the application of BoLPAS Program to Power Plant.** Kim, K.Y. (Korea Electric Power Corp. (KEPCO), Taejon (Korea, Republic of). Research Center); Back, S.K.; Ha, J. S.; Kim, H.K.; Kang, M.S.; Song, K.W.; Ku, M.H. Korea Electric Power Corp. (KEPCO), Taejon (Korea, Republic of). Research Center. 1994. 277p. (In Korean). Order Number DE96703586. Source: OSTI; NTIS (US Sales Only).

Totally 25 units of all the fossil power plants in korea are more than 15 years old, but the construction of new power plant has met some difficulties such as siting, licensing, environmental and capital resources, etc. To meet the rapid electrical demands, it is required to extend the life of existing plants. To evaluate the remaining life of the boiler header and high energy pipe of the thermal power plant in korea, BoLPAS program was selected as a life evaluating tool. To evaluate the fossil power plant Pipe life using BoLPAS code, investigation of power plant to get the information as followings - unit running hour -number of start-up(cold, warm, hot etc.) -failure history -design parameter -operation parameter regarding high temperature pipe system -pipe specifications. Design and maintenance standards of the high energy piping was investigated and the output of the BoLPAS program were investigated to extend the life of the thermal power plants in Korea. fig.

29436 (KRC–93Y-T03) **Circulating Fluidized Bed Combustion of Korean Anthracite.** Kee, P.S. (Korea Electric Power Corp. (KEPCO), Taejon (Korea, Republic of). Research Center); Wee, Y.H.; Ahn, D.H.; Chung, J.D.; Lee, J.S.; Park, H.Y.; Sun, D.W.; Son, J.I.; Kim, Y.S.; Park, Y.S.; Lee, Y.W.; Han, K.H.; Bae, D.H.; Cho, S.H. Korea Electric Power Corp. (KEPCO), Taejon (Korea, Republic of). Research Center. 1994. 138p. (In Korean). Order Number DE96703591. Source: OSTI; NTIS (US Sales Only).

Circulating fluidized bed combustion(CFBC) provides major technological advantages of fuel variation, in situ sulfur retention, nitric oxide suppression over conventional coal combustion technologies. This technology, developed mainly in the U.S.A. and European countries, is protected as a highly advanced technology. First CFBC boiler unit was installed in 1985 by Hyundai Heavy Industry and Pyropower in the U.S.A.. Since then about 10 units were installed in korea until today. However, Due to the negligence of domestic research and development, distributions in korea has depended mainly on the import of foreign skill. Hence, These cause various troubles from the commissioning stage generating disadvantages to users. This project aims at the study if circulating fluidized bed combustion characteristics of korean anthracite which has rarely been investigated up until now. The result of this study will provided data useful to the design of power plants using circulating fluidized bed boilers and also to the trouble shooting and performance improvement of the boilers.(author). 22 refs., fig.

29437 (NEDO-P–9415) **Survey on promotion of construction of the waste utilization energy system in the cold area.** New Energy and Industrial Technology Development Organization, Tokyo (Japan). Mar 1995. 207p. (In Japanese). Order Number DE96704401. Source: OSTI; NTIS; Available from New Energy and Industrial Technology Development Organization, Sunshine 60, 30F 1-1, 3-chome, Higashi-Ikebukuro, Toshima-ku, Tokyo, Japan.

The paper surveys the amount of waste which can be energy resource in the snowy and cold area in Hokkaido, constructs an energy system highly viable for effective use of this resource, and studies methods for the use. Energy demand in Hokkaido is characterized by a big difference in energy consumption between summer and winter, which is attributed to the demand for domestic use air heating in winter. The amount of flammable waste which is usable as energy resource is approximately 255,000 tons, about 73.3% of which is from wood chips. As types of the system for using waste as energy, model systems in the following four areas are assumed to study energy balance: slight cold district - urban/fishery district, cold district - urban district, cold district - urban/fishery district, and extreme cold district - agricultural district. As a result, energy saving effects of the system to use waste as energy are very large in the cold area, and a possibility of the introduction is estimated to be great, even if it is the model in small-size waste treatment facilities. 122 figs., 61 tabs.

29438 (NREL/CP–200-8098, pp. 382-389) **Cofiring wood waste and coal in cyclone boilers: Test results and prospectus.** Tillman, D. (and others); Stahl, R.; Bradshaw, D. National Renewable Energy Lab., Golden, CO (United States). [1995]. (CONF-9508104–: 2. meeting on biomass of the Americas, Portland, OR (United States), 21-24 Aug 1995). In *Second biomass conference of the Americas: Energy, environment, agriculture, and industry. Proceedings.* 1741p. Order Number DE95009230. Source: OSTI.

Cofiring wood waste in coal-fired utility boilers has the potential to reduce fuel costs, support local economic development, and address environmental concerns ranging from NO_x emissions to greenhouse gas emissions. Consequently, TVA and EPRI developed an extensive program initially involving case studies and calculations, and extending into the conduct of cofiring tests at Boiler No. 2 of the Allen Fossil Plant. This boiler is a 265 MW cyclone unit, and it was tested in August 1994. The wood waste cofired was sawdust obtained locally, and the coal employed was an eastern bituminous coal. During this test, measurements were made to evaluate the influence of cofiring on fuel preparation and handling, fuel management operations, boiler efficiencies and operating temperatures, and the formation and control of airborne emissions. The tests demonstrated the potential for significant technical, economic, and environmental benefits associated with wood cofiring, including improving dust control during fuel handling, achieving 100% boiler capacities while cofiring, experiencing minimum impacts on boiler efficiency, and achieving reductions in such pollutants as NO_x. Those tests are being repeated, cofiring wood waste with Utah bituminous coal. This paper reports on the results of the test program to date, and it considers the implication of the test results. Specific attention is given to the quantitative results with respect to the following parameters: ability to achieve capacity, boiler efficiency, combustion temperatures and furnace exit temperatures, opacity, NO_x emissions, and related performance measurements.

29439 (NREL/CP–200-8098, pp. 390-399) **Cofiring waste biofuels and coal for emissions reduction.** Brouwer, J. (Reaction Engineering International, Salt Lake City, UT (United States)); Owens, W.D.; Harding, N.S. National Renewable Energy Lab., Golden, CO (United States). [1995]. (CONF-9508104–: 2. meeting on biomass of the Americas, Portland, OR (United States), 21-24 Aug 1995). In *Second biomass conference of the Americas: Energy, environment, agriculture, and industry. Proceedings.* 1741p. Order Number DE95009230. Source: OSTI.

Combustion tests have been performed in two pilot-scale combustion facilities to evaluate the emissions reduction possible while firing coal blended with several different biofuels. Two different boiler simulations, pulverized coal fired boilers and stoker coal fired boilers, were simulated. The pc-fired studies investigated the use of waste hardwood and softwood with pulverized coal, or using the biofuels as potential reburning fuels. The use of these wood waste is attractive because: wood contains little nitrogen and virtually no sulfur; wood is a regenerable biofuel; and wood utilization results in a net reduction in CO_2 emissions. The wood reburning results indicate a reduction of 50-60% NO with approximately 10% wood heat input. Reburn stoichiometry was the most important variable. The NO reduction was strongly dependent upon initial NO and only slightly dependent upon temperature and wood moisture content. Cofiring of wood with pulverized coal; however, did not lead to significant NO reductions with the current NO_x burner configuration. The stoker program investigated barriers for the successful blending of coal with waste railroad ties. Parameters evaluated included blending firing rate, chip size, optimum feed location, overfire/underfire air ratio, and natural gas addition. The results of this study demonstrate that NO emissions can be reduced by more than 50% without any significant increase in CO or THC emissions by the proper use of zoned reburning. Both programs demonstrated several benefits of biofuel cofiring, including: (1) lower operating costs due to reduced fuel prices; (2) reduced waste disposal; (3) reduced maintenance costs; (4) reduced environmental costs; and (5) extension of the useful life of existing equipment.

29440 (NREL/CP–200-8098, pp. 637-646) **Development of a new generation of small scale biomass-fueled electric generating power plants.** Craig, J.D. (Cratech, Inc., Tahoka, TX (United States)); Purvis, C.R. National Renewable Energy Lab., Golden, CO (United States). [1995]. (CONF-9508104–: 2. meeting on biomass of the Americas, Portland, OR (United States), 21-24 Aug 1995). In *Second biomass conference of the Americas: Energy, environment, agriculture, and industry. Proceedings.* 1741p. Order Number DE95009230. Source: OSTI.

There exists a need by a large worldwide market for greatly improved small scale (1 to 20 MWe per unit) biomass-fueled power plants. These power plants will significantly increase the efficiency of generating electric power from wood and bagasse as well as convert non-traditional fuel sources such as rice hulls, animal manure, cotton gin trash, straws, and grasses to electricity. Advancing the technology of biomass-fueled power plants will greatly expand the use of this environmentally friendly sustainable 24 hr-per-day source of electrical power for industry and communities worldwide. This paper briefly describes the status of a biomass-fueled power plant under development by Cratech, Inc.

29441 (NREL/CP–200-8098, pp. 695-701) **Biomass gasification - A way to achieve competitive electricity production in the UK.** Barker, S.N.; Marshall, A.R.; Band, M.H.W. National Renewable Energy Lab., Golden, CO (United States). [1995]. (CONF-9508104–: 2. meeting on biomass of the Americas, Portland, OR (United States), 21-24 Aug 1995). In *Second biomass conference of the Americas: Energy, environment, agriculture, and industry. Proceedings.* 1741p. Order Number DE95009230. Source: OSTI.

In 1993 the European Commission announced that they would part fund the building of one or more demonstration projects using biomass gasification to produce power. Fluidised bed reactors and gas turbine cycles were preferred and the fuel supply was to be short rotation coppice. As this initiative was very much in line with UK policy, the National Programme actively encouraged the preparation of a UK based bid. It became clear during the course of this that the proposed demonstration would be very expensive because of its small size and innovative nature. The question had to be asked whether support was justified on the grounds that the technology would become fully commercial in the future. The work by Larson et al. and Shell indicated that this would be the case but the magnitude of the investment meant that verification would be needed for UK conditions. Babcock Energy, a major UK engineering company, were contracted by the National Programme to carry out capital costing and performance calculations for a series of cases. The first was the demonstration at 8MWe and from this two future cases were derived at 30MWe - the first full size prototype and the tenth replication. Only conservative assumptions were made in deriving the future cases and costs were directly traceable either to the demonstration case or vendor quotes. The technology was atmospheric pressure gasification, based on TPS technology, linked to a gas turbine combined cycle. For the tenth replication a capital cost of $1176/kWe installed was obtained, inclusive of civils. To determine base line fuel costs ETSU sponsored studies in the areas surrounding potential sites to determine a market price for short rotation coppice. Future prices were developed from this base line using yield and cost projections derived in consultation

with farming and forestry research bodies as part of the National Programme.

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Refer also to citation(s) 28592, 28645, 28646, 28647, 28648, 28649, 28650, 28651, 28652, 28653, 28654, 29446

29442 (DOE/PC/90542–T10) **10-MW demonstration of the gas suspension absorption process at TVA's Center for Emissions Research. Final report.** Tennessee Valley Authority, Chattanooga, TN (United States). Mar 1995. 170p. Sponsored by USDOE, Washington, DC (United States);Tennessee Valley Authority, Knoxville, TN (United States). DOE Contract FC22-91PC90542. Order Number DE96000327. Source: OSTI; NTIS; GPO Dep.

The Tennessee Valley Authority (TVA) in cooperation with AirPol Inc., and the U.S. Department of Energy (DOE), has recently completed a successful 17-month test program with the AirPol Gas Suspension Absorption (GSA) flue gas desulfurization (FGD) process at TVA's Center for Emissions Research (CER). This project was selected by DOE for funding in the third round of the Clean Coal Technology Program. This 10-MW demonstration of the GSA FGD system at the CER was the first application of this technology in the U.S. The GSA test program, which was cofunded two-thirds by TVA and one-third by DOE/AirPol, was completed over a 17-month period from November 1, 1992 to March 31, 1993. This test program demonstrated that the GSA FGD technology could achieve high SO_2 removal efficiencies (90+ percent) for a 2.7 percent sulfur (as-fired) coal application, while maintaining particulate emissions below the New Source Performance Standards (NSPS), i.e., 0.03 lb/MBtu, in a four-field electrostatic precipitator. The reliability and operability of this system was also demonstrated in a 28-day, 24 hour/day, continuous run during which the GSA unit simultaneously achieved high SO_2 removal efficiencies (90+ percent) and maintained particulate emissions below the NSPS. Also, the air toxics removal capabilities of the GSA system were determined in a series of tests. A 1-MW pulsejet baghouse (PJBH) pilot plant was also tested in conjunction with this GSA test program. This PJBH testing was initially cofunded by TVA and the Electric Power Research Institute, who were later joined by AirPol and DOE in sponsoring this PJBH testing. A 14-day PJBH demonstration run was also completed to confirm the reliability of this system.

29443 (DOE/PC/90547–T20) **Evaluation of gas reburning and low NO_x burners on a wall-fired boiler.** Energy and Environmental Research Corp., Irvine, CA (United States). Jun 1995. 200p. Sponsored by USDOE, Washington, DC (United States). DOE Contract FC22-91PC90547. Order Number DE95017755. Source: OSTI; NTIS; GPO Dep.

An evaluation of Gas Reburning (GR) and Low NO_x, Burners (LNB) has been completed at Public Service Company of Colorado's Cherokee Station Unit 3. The goal of the demonstration, which was carried out in a US DOE Clean Coal Technology Round 3 Program, was to reduce NO_x emissions by 70%. The reduction was to be achieved from the pre-project level, prior to LNB retrofit. The GR system was supplied by Energy and Environmental Research Corporation (EER) and the LNBs were supplied by the Foster Wheeler Energy Corporation. The project was carried out in three phases in which EER designed the GR system and obtained necessary permits (Phase 1), constructed the system and completed start-up tasks (Phase 2), and evaluated its performance with both Optimization Tests and a Long-Term Demonstration (Phase 3). As directed by the cooperative agreement, environmental monitoring was conducted in each phase. Measurements were taken by plant personnel and an EER Field Testing Team and were divided into two types. "Compliance Monitoring" was conducted by plant personnel to satisfy requirements of regulatory agencies, while "Supplemental Monitoring" was conducted by EER personnel to develop a database of environmental impacts of the technology and to ensure environmental acceptability of the project. This document presents environmental monitoring data obtained during the Long-Term Testing period, April 27, 1993 to January 27, 1995. During this period, ten months of testing of the GR-LNB system was followed by a modification into a "second-generation" GR-LNB system, which was evaluated for six months. Compliance Monitoring was conducted primarily in two areas, air emissions and aqueous discharges.

29444 (DOE/PC/91338–T9) **High efficiency SO_2 removal testing. Quarterly report, 1 January–31 March 1995.** Radian Corp., Austin, TX (United States). 11 Apr 1995. 13p. Sponsored by USDOE, Washington, DC (United States). DOE Contract AC22-92PC91338. Order Number DE95015520. Source: OSTI; NTIS; GPO Dep.

This project involves testing at six full-scale utility flue gas desulfurization (FGD) systems, to evaluate low capital cost upgrades that may allow these systems to achieve up to 98% SO_2 removal efficiency. The upgrades being evaluated mostly involve using additives in the FGD systems. The "base" project involved testing at the Tampa Electric Company Big Bend station. All five potential options to the base program have been exercised by DOE, involving testing at the Hoosier Energy Merom Station (Option 1), the Southwestern Electric Power Company Pirkey Station (Option 11), the PSI Energy Gibson Station (Option III), the Duquesne Light Elrama Station (Option IV), and the New York State Electric and Gas Corporation's (NYSEG) Kintigh Station (Option V). Testing has been completed for all six sites. Following the introduction, this document divided into four sections. Section 2, Project Summary, provides a brief overview of the status of technical efforts on this project. Section 3, Results, summarizes the outcome from these technical efforts during the quarter. In Section 4, Plans for the Next Reporting Period, an overview is provided of the technical efforts that are anticipated for the second quarter of calendar year 1995. Section 5 contains a brief acknowledgement.

29445 (KRC–91C-T02) **Study on the Utilization of Fly Ash as a Soil Amendment.** Park, C.H. (Korea Electric Power Corp. (KEPCO), Taejon (Korea, Republic of). Research Center); Yuk, C.S.; Lim, S.Y.; Kim, J.J.; Yoo, S.H.; Yoo, I.S.; Ha, H.S.; Shin, J.S.; Kim, Y.S.; Kim, B.Y.; Cho, Y.G.; Yoon, J.H.; Cho, I.S. Korea Electric Power Corp. (KEPCO), Taejon (Korea, Republic of). Research Center. 1994. 436p. (In Korean). Order Number DE96703573. Source: OSTI; NTIS (US Sales Only).

Fly ash contains high level of phosphorus, potassium and boron those are useful elements to plant growth and its particle size distribution is so various. There is enough ground for improving the soil properties such as nutrition supply, water retention, porosity, sickly and pressure resistence. Fly ash utilization in agriculture was planned as a part of mid-long term research to develop treatment and utilization methods of waste materials, and to practise in farm level. This study was designed to find out the optimum rate of fly ash application to two soils, fine loamy and coarse loamy, through the laboratory and field research on the effects of fly ash on the changes of soil properties and crop growth. The application rate of fly ash per 10 ares at highest rice yields in the first year were bituminous coal ash of 12.0 ton and anthracite coal ash of 4.7 ton at coarse loamy, and bituminous coal ash of 2.5 ton and anthracite coal ash of 3.9 ton at fine loamy and the average of above application rates was 5.8 ton and the effects were continued to the third year. The application rate of fly ash per 10 ares at highest soybean yields in the first year were bituminous coal ash of 2.5 ton and anthracite coal ash was no effect at coarse loamy, and bituminous coal ash of 7.3 ton and anthracite coal ash of 8.4 ton at fine loamy. (author). 60 refs., figs.

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Refer also to citation(s) 29838

29446 (DOE/EA–1080) **Commercial demonstration of the NOXSO SO_2/NO_x removal flue gas cleanup system.** Renk, J.B. III. USDOE Pittsburgh Energy Technology Center, PA (United States). Jun 1995. 50p. Sponsored by USDOE, Washington, DC (United States). Order Number DE96000179. Source: OSTI; NTIS; GPO Dep.

This environmental assessment (EA) was prepared to evaluate the potential impacts of a proposed demonstration project to be cost-shared by DOE and NOXSO Corporation under the terms of Clean Coal Technology (CCT) Demonstration Program. The project would demonstrate the NOXSO flue gas treatment technology,

which is designed to reduce sulfur dioxide (SO_2) and nitrogen oxides (NO_x) emissions from existing coal-fired electric generating units. Its objective is to introduce advanced, efficient, reliable, and environmentally improved coal utilization technologies to the U.S. energy marketplace, in order to reduce or eliminate economic and environmental barriers to the continued use of coal as an energy source. This EA represents the third level of DOE's NEPA strategy: the preparation and public distribution of NEPA documents for each project selected for financial assistance under the PON. It contains a site-specific environmental impact analysis of the proposed federal action, and will result in either a Finding of No Significant Impact, or a determination that significant impacts may occur, in which case an Environmental Impact Statement must be prepared. The sources of information for this EA include the technical proposal for the project submitted by NOXSO in response to the CCT Round III PON; discussions with NOXSO and their consultants; discussions with federal, state and local agencies; the April 1995 NOXSO Environmental Information Volume provided to DOE for the project; and visits to the proposed project sites.

29447 (DOE/MC/26042–4083) **A study of hazardous air pollutants at the Tidd PFBC Demonstration Plant.** American Electric Power Service Corp., Columbus, OH (United States). Oct 1994. 500p. Sponsored by USDOE, Washington, DC (United States). DOE Contract FC21-89MC26042. Order Number DE95009729. Source: OSTI; NTIS; INIS; GPO Dep.

The US Department of Energy (DOE) Clean Coal Technology (CCD Program is a joint effort between government and industry to develop a new generation of coal utilization processes. In 1986, the Ohio Power Company, a subsidiary of American Electric Power (AEP), was awarded cofunding through the CCT program for the Tidd Pressure Fluidized Bed Combustor (PFBC) Demonstration Plant located in Brilliant, Ohio. The Tidd PFBC unit began operation in 1990 and was later selected as a test site for an advanced particle filtration (APF) system designed for hot gas particulate removal. The APF system was sponsored by the DOE Morgantown Energy Technology Center (METC) through their Hot Gas Cleanup Research and Development Program. A complementary goal of the DOE CCT and METC R&D programs has always been to demonstrate the environmental acceptability of these emerging technologies. The Clean Air Act Amendments of 1990 (CAAA) have focused that commitment toward evaluating the fate of hazardous air pollutants (HAPs) associated with advanced coal-based and hot gas cleanup technologies. Radian Corporation was contacted by AEP to perform this assessment of HAPs at the Tidd PFBC demonstration plant. The objective of this study is to assess the major input, process, and emission streams at Plant Tidd for the HAPs identified in Title III of the CAAA. Four flue gas stream locations were tested: ESP inlet, ESP outlet, APF inlet, and APF outlet. Other process streams sampled were raw coal, coal paste, sorbent, bed ash, cyclone ash, individual ESP hopper ash, APF ash, and service water. Samples were analyzed for trace elements, minor and major elements, anions, volatile organic compounds, dioxin/furan compounds, ammonia, cyanide, formaldehyde, and semivolatile organic compounds. The particle size distribution in the ESP inlet and outlet gas streams and collected ash from individual ESP hoppers was also determined.

2006 Economic, Industrial, and Business Aspects

Refer also to citation(s) 29445

21 NUCLEAR POWER REACTORS AND ASSOCIATED PLANTS

Refer also to citation(s) 31401

29448 (IAEA-TECDOC–801) **Development of safety principles for the design of future nuclear power plants.** International Atomic Energy Agency, Vienna (Austria). Jun 1995. 60p. Order Number DE96602724. Source: OSTI; NTIS (US Sales Only); INIS.

The main purpose of this TECDOC is to propose updates to existing safety principles which could be used as a basis for developing safety principles for the design of future NPPs. Accordingly, this document is intended to be useful to reactor designers, owners, operators, researchers and regulators. It is also expected that this document can contribute to international harmonization of safety approaches, and that it will help ensure that future reactors will be designed worldwide to a high standard of safety. As such, these proposed updates are intended to provide general guidance which, if carefully and properly implemented, will result in reactor designs with enhanced safety characteristics beyond those currently in operation. This enhancement results from the fact that the proposals are derived from the lessons learned from more recent operational experience, R and D, design, testing, and analysis developed over the past decade or so, as well as from attempts to reflect the current trends in reactor design, such as the introduction of new technologies. 8 refs, 3 figs.

29449 (PNL–10791) **Recommendations for the treatment of aging in standard technical specifications.** Orton, R.D.; Allen, R.P. Pacific Northwest Lab., Richland, WA (United States). Sep 1995. 150p. Sponsored by Nuclear Regulatory Commission, Washington, DC (United States). DOE Contract AC06-76RL01830. Order Number DE96000693. Source: OSTI; NTIS; INIS; GPO Dep.

As part of the US Nuclear Regulatory Commission's Nuclear Plant Aging Research Program, Pacific Northwest Laboratory (PNL) evaluated the standard technical specifications for nuclear power plants to determine whether the current surveillance requirements (SRs) were effective in detecting age-related degradation. Nuclear Plant Aging Research findings for selected systems and components were reviewed to identify the stressors and operative aging mechanisms and to evaluate the methods available to detect, differentiate, and trend the resulting aging degradation. Current surveillance and testing requirements for these systems and components were reviewed for their effectiveness in detecting degraded conditions and for potential contributions to premature degradation. When the current surveillance and testing requirements appeared ineffective in detecting aging degradation or potentially could contribute to premature degradation, a possible deficiency in the SRs was identified that could result in undetected degradation. Based on this evaluation, PNL developed recommendations for inspection, surveillance, trending, and condition monitoring methods to be incorporated in the SRs to better detect age- related degradation of these selected systems and components.

2101 Power Reactors, Nonbreeding, Light-Water Moderated, Boiling Water Cooled

Refer also to citation(s) 28780, 28781, 29146, 29470, 29577, 29609, 29624, 29627, 29628, 29637, 29642, 29643, 29657, 29658, 29659, 29660, 29663, 29672, 29677, 29679, 29680, 29681, 29701, 29702, 29703, 29704, 29705, 29706, 29707, 29708, 29709, 29710, 29711, 29712, 29713, 29714, 29716, 29717, 29719, 29720, 29721, 29723, 29727, 29736, 29737, 29744, 29749, 29753, 29771, 29772, 29773, 29775, 29777

29450 (ANL/ET/CP–83023) **Statistical analysis of fatigue strain-life data for carbon and low-alloy steels.** Keisler, J.; Chopra, O.K. Argonne National Lab., IL (United States). Mar 1995. 12p. Sponsored by Nuclear Regulatory Commission, Washington, DC (United States). DOE Contract W-31-109-ENG-38. (CONF-950740–85: Joint ASME/JSME pressure vessels and piping conference, Honolulu, HI (United States), 23-27 Jul 1995). Source: OSTI; NTIS; INIS.

The existing fatigue strain vs life (S-N) data, foreign and domestic, for carbon and low-alloy steels used in the construction of nuclear power plant components have been compiled and categorized according to material, loading, and environmental conditions. A statistical model has been developed for estimating the effects of the various test conditions on fatigue life. The results of a rigorous statistical analysis have been used to estimate the probability of initiating a fatigue crack. Data in the literature were reviewed to evaluate the effects of size, geometry, and surface finish of a component on its fatigue life. The fatigue S-N curves for components have been determined by applying design margins for size, geometry, and surface finish to crack initiation curves estimated from the model.

29451 (DOE/ER/75701–2) **Nodal analysis of two-phase instabilities.** Lahey, R.T. Jr.; Garea, V.P. Rensselaer Polytechnic Inst., Troy, NY (United States). Center for Multiphase Research. [1995]. 37p. Sponsored by USDOE, Washington, DC (United States). DOE Contract FG02-92ER75701. Order Number DE96000286. Source: OSTI; NTIS; INIS; GPO Dep.

Nodal models having moving nodal boundaries have been developed for the analysis of two-phase flow instabilities in a boiling channel. The first model, which was based on a Galerkin method for the discretization, has been found to be accurate in the prediction of the onset of instabilities as well as the frequency of oscillations. This model however, had some problems with the prediction of chaotic phenomena and did not allow for flow reversal in the channel. A second nodal model, based on a finite difference approach, has been found to perform better for the prediction of non-linear response and it also allows for flow reversal. Both models are numerically more efficient than the existing fixed grid models for instabilities analysis.

29452 (EGG–10617-1230) **An aerial radiological survey of the Vermont Yankee Nuclear Power Station and surrounding area, Vernon, Vermont.** Reiman, R.; Bluitt, C.M. EG and G Energy Measurements, Inc., Las Vegas, NV (United States). Remote Sensing Lab. Oct 1993. 12p. Sponsored by Nuclear Regulatory Commission, Washington, DC (United States). DOE Contract AC08-88NV10617. Order Number DE96001126. Source: OSTI; NTIS; INIS; GPO Dep.

An aerial radiological survey was conducted over the Vermont Yankee Nuclear Power Station in Vernon, Vermont, during the period August 7 through August 17, 1989. The survey was conducted at an altitude of 300 feet (91 meters) over a 65-square-mile (168-square-kilometer) area centered on the power station. The purpose of the survey was to document the terrestrial gamma radiation environment of the Vermont Yankee Power Station and surrounding area. The results of the aerial survey are reported as inferred gamma radiation exposure rates at 1 meter above ground level in the form of a contour map. Outside the plant boundary, exposure rates were found to vary between 6 and 10 microroentgens per hour (μR/h) and were attributed to naturally occurring uranium, thorium, and radioactive potassium gamma emitters. The aerial data were compared to ground-based "benchmark" exposure rate measurements and radionuclide assays of soil samples obtained within the survey boundary. The ground-based measurements were found to be in good agreement with those inferred from the aerial measuring system.

29453 (INIS-mf–14561, pp. 25-33) **Reactor physics characteristics of possible fuel materials for plutonium-incinerating LWRs.** Kasemeyer, U. (Paul Scherrer Inst. (PSI), Villigen (Switzerland)); Paratte, J.M.; Chawla, R. [1995]. 125p. In *Paul Scherrer Institut annual report 1994. Annex IV: PSI nuclear energy and safety research progress report 1994.* Order Number DE96601628.

A range of mixtures of plutonium and different burnable poisons (BPs) have been considered from the viewpoint of providing a possible LWR fuel without uranium. The reactor physics feasibility of such materials for enabling a considerably more effective incineration of plutonium than is possible with PuO_2/UO_2 (MOX) fuel has been investigated in terms of burnup reactivity swings, temperature and void coefficients and control absorber worths. The potential for reduction of total-Pu has been shown to be $\simeq$3 times greater than with MOX, the difference in possible reduction factors being much more striking in terms of the quantity of fissile-Pu. It has been found that the specific effects of a given BP are crucial in determining the burnup and controllability characteristics of the hypothetical LWR fuel considered. As such, an improved overall performance can result from using a suitable mixture of BPs, rather than one individual type. Further, the influence of the 'inert matrix' employed for the Pu-BP fuel can also be significant - on the void coefficient, in particular. The need has thus been indicated for optimizing the Pu-BP fuel composition in terms of both the BPs and the inert matrix. Finally, the scoping character of the present investigations needs to be stressed. The various results have all been obtained on the basis of unit cell and simplified fuel assembly calculations, and there has been little explicit consideration of materials aspects as such. (author) 5 figs., 9 tabs., 11 refs.

29454 (INIS-mf–14561, pp. 35-44) **The ALPHA project: a progress report.** Yadigaroglu, G. (Eidgenoessische Technische Hochschule, Zurich (Switzerland)); Cachard, F. de; Coddington, P.; Dreier, J.; Smith, B.; Guentay, S.; Varadi, G. [1995]. 125p. In *Paul Scherrer Institut annual report 1994. Annex IV: PSI nuclear energy and safety research progress report 1994.* Order Number DE96601628.

A review of the ALPHA project is presented, including a summary of progress and current status. The project comprises the experimental and analytical investigation of the long-term decay heat removal phenomena from the containment of the next generation of 'passive' Advanced Light Water Reactors. The effects of aerosols that may result from hypothetical severe accidents are also considered. The construction of the major ALPHA experimental facilities, PANDA, LINX-2 and AIDA, has been completed and all facilities are now in their commissioning phases. Scaling studies have guided the design of the experimental facilities. Several small-scale experiments and studies have already produced valuable results which can be used to direct the experimental work, as well as the design of the passive ALWRs. (author) 7 figs., 23 refs.

29455 (INIS-mf–14561, pp. 45-55) **CSNI separate effects test validation matrix: general description and methodology.** Aksan, N. (Paul Scherrer Inst. (PSI), Villigen (Switzerland)); D'Auria, F.; Glaeser, H.; Pochard, R.; Richards, C.; Sjoeberg, A. [1995]. 125p. In *Paul Scherrer Institut annual report 1994. Annex IV: PSI nuclear energy and safety research progress report 1994.* Order Number DE96601628.

An internationally agreed Separate Effects Test (SET) validation matrix for thermal-hydraulic system codes has been established by a sub-group of the Task Group on Thermal Hydraulic System Behaviour as requested by the OECD/NEA Committee on Safety of Nuclear Installations (CSNI) Principal Working Group No. 2 on Coolant System Behaviour. The construction of such a matrix is an attempt to collect together, in a systematic way, the best sets of openly available test data for code validation, assessment and improvement and also for quantitative code assessment with respect to quantification of uncertainties to the modelling of individual phenomena by the codes. In this paper, the methodology that has been developed during the process of establishing a SET validation matrix is discussed in detail, together with a general overview of the resulting SET matrix. Some specific examples from the SET matrix will also be provided. The conclusions which are obtained by applying the methodology to the establishment of SET validation matrix will so be summarised. The present paper is the first of a series of three papers. The other two papers address the thermal hydraulic phenomena in the SCNI-SET validation matrix and the evaluation of the SET matrix data base. (author) 4 tabs., 7 refs.

29456 (INIS-mf–14561, pp. 57-60) **Prevention of ignitions in the LWR-containment atmosphere by carbon dioxide inertisation under severe accident conditions.** Nobbenhuis-Wedda, H. (Paul Scherrer Inst. (PSI), Villigen (Switzerland)); Alder, H.P. [1995]. 125p. In *Paul Scherrer Institut annual report 1994. Annex IV: PSI nuclear energy and safety research progress report 1994.* Order Number DE96601628.

For Light Water Reactors (LWRs), the containment is the last barrier against radioactive emission to the environment under severe accident conditions. The containment atmosphere is composed of inert gases, e.g. nitrogen, oxidizing gases, e.g. oxygen, and reactive gases, e.g. hydrogen. Depending on composition, this gas mixture may be subject to uncontrolled combustion or explosion processes with accompanying pressure and temperature increases during severe accidents. Pressure control is of utmost importance to assure containment integrity. One method to exclude containment atmosphere ignition in a deterministic way is to flood the containment in the early stages of a severe accident by an inert gas, e.g. carbon dioxide. The purpose of this work was to determine the ignition limits of the four component gas mixture: CO_2, steam, air and H_2 under conditions as they may occur in the containment in the initial phase of a severe accident. The ignition experiments were carried out in an autoclave with a volume of 34 litres; large enough to avoid geometry effects. The autoclave was equipped with high energy ignition sources and a fan to assure effective gas mixing. Starting with a base load of 1 bar air at 35°C,

H_2, CO_2 and H_2O were added and the ignition limits, the pressure peak and the residual gas composition determined. (author) 4 figs., 1 tab., 3 refs.

29457 (INIS-mf–14561, pp. 95-106) **Project CORVIS - research on RPV lower head failure.** Hirschmann, H. (Paul Scherrer Inst. (PSI), Villigen (Switzerland)); Duijvestijn, G.; Jaeckel, B.S.; Nakada, K.; Patorski, J.; Seifert, H.P. [1995]. 125p. In *Paul Scherrer Institut annual report 1994. Annex IV: PSI nuclear energy and safety research progress report 1994.* Order Number DE96601628.

The Project CORVIS is a research programme for the experimental and analytical investigation of a possible melting-through of the pressure vessel of a light water reactor during a core-melt accident. We report in detail on a small scale experiment and the results of a computational reconstruction of heat transfer phenomena observed in this experiment. Further, preliminary remarks on the most recent large scale experiment on a model of a BWR-drain line are made. (author) 22 figs., 1 tab., 13 refs.

29458 (JAERI-Review–95-006) **Severe accidents at nuclear power plants. Their risk assessment and accident management.** Abe, Kiyoharu. Japan Atomic Energy Research Inst., Tokyo (Japan). May 1995. 138p. (In Japanese). Order Number DE96701320. Source: OSTI; NTIS; INIS.

This document is to explain the severe accident issues. Severe Accidents are defined as accidents which are far beyond the design basis and result in severe damage of the core. Accidents at Three Mild Island in USA and at Chernobyl in former Soviet Union are examples of severe accidents. The causes and progressions of the accidents as well as the actions taken are described. Probabilistic Safety Assessment (PSA) is a method to estimate the risk of severe accidents at nuclear reactors. The methodology for PSA is briefly described and current status on its application to safety related issues is introduced. The acceptability of the risks which inherently accompany every technology is then discussed. Finally, provision of accident management in Japan is introduced, including the description of accident management measures proposed for BWRs and PWRs. (author).

29459 (NUREG–1123-Rev.1) **Knowledge and abilities catalog for nuclear power plant operators: Boiling water reactors, Revision 1.** Nuclear Regulatory Commission, Washington, DC (United States). Office of Nuclear Reactor Regulation. Aug 1995. 300p. Sponsored by Nuclear Regulatory Commission, Washington, DC (United States). Source: OSTI; NTIS; INIS; GPO.

The Knowledge and Abilities Catalog for Nuclear Power Plant Operators: Boiling-Water Reactors (BWRs) (NUREG-1123, Revision 1) provides the basis for the development of content-valid licensing examinations for reactor operators (ROs) and senior reactor operators (SROs). The examinations developed using the BWR Catalog along with the Operator Licensing Examiner Standards (NUREG-1021) and the Examiner's Handbook for Developing Operator Licensing Written Examinations (NUREG/BR-0122), will cover the topics listed under Title 10, Code of Federal Regulations, Part 55 (10 CFR 55). The BWR Catalog contains approximately 7,000 knowledge and ability (K/A) statements for ROs and SROs at BWRs. The catalog is organized into six major sections: Organization of the Catalog, Generic Knowledge and Ability Statements, Plant Systems grouped by Safety Functions, Emergency and Abnormal Plant Evolutions, Components, and Theory. Revision 1 to the BWR Catalog represents a modification in form and content of the original catalog. The K/As were linked to their applicable 10 CFR 55 item numbers. SRO level K/As were identified by 10 CFR 55.43 item numbers. The plant-wide generic and system generic K/As were combined in one section with approximately one hundred new K/As. Component Cooling Water and Instrument Air Systems were added to the Systems Section. Finally, High Containment Hydrogen Concentration and Plant Fire On Site evolutions added to the Emergency and Abnormal Plant Evolutions section.

29460 (NUREG/CP–0142-Vol.4, pp. 2608-2620) **Experience using individually supplied heater rods in critical power testing of advanced BWR fuel.** Majed, M. (ABB Atom AB, Vasteras (Sweden)); Morback, G.; Wiman, P. Nuclear Regulatory Commission, Washington, DC (United States). Div. of Systems Technology; American Nuclear Society, La Grange Park, IL (United States); American Inst. of Chemical Engineers, New York, NY (United States); American Society of Mechanical Engineers, New York, NY (United States); Canadian Nuclear Society, Toronto, ON (Canada); European Nuclear Society (ENS), Bern (Switzerland); Atomic Energy Society of Japan, Tokyo (Japan); Japan Society of Multiphase Flow, Kyoto (Japan). Sep 1995. (CONF-950904–Vol.4: 7. international meeting on nuclear reactor thermal hydraulics, Saratoga, NY (United States), 10-15 Sep 1995). In *Proceedings of the 7th International Meeting on Nuclear Reactor Thermal-Hydraulics NURETH-7. Sessions 17-24.* 825p. Source: OSTI; NTIS; INIS; GPO.

The ABB Atom FRIGG loop located in Vasteras Sweden has during the last six years given a large experience of critical power measurements for BWR fuel designs using indirectly heated rods with individual power supply. The loop was built in the sixties and designed for maximum 100 bar pressure. Testing up to the mid eighties was performed with directly heated rods using a 9 MW, 80 kA power supply. Providing test data to develop critical power correlations for BWR fuel assemblies requires testing with many radial power distributions over the full range of hydraulic conditions. Indirectly heated rods give large advantages for the testing procedure, particularly convenient for variation of individual rod power. A test method being used at Stern Laboratories (formerly Westinghouse Canada) since the early sixties, allows one fuel assembly to simulate all required radial power distributions. This technique requires reliable indirectly heated rods with independently controlled power supplies and uses insulated electric fuel rod simulators with built-in instrumentation. The FRIGG loop was adapted to this system in 1987. A 4MW power supply with 10 individual units was then installed, and has since been used for testing 24 and 25 rod bundles simulating one subbundle of SVEA-96/100 type fuel assemblies. The experience with the system is very good, as being presented, and it is selected also for a planned upgrading of the facility to 15 MW.

29461 (NUREG/CP–0142-Vol.4, pp. 2677-2703) **Stability analysis of BWR nuclear-coupled thermal-hyraulics using a simple model.** Karve, A.A. (Univ. of Virginia, Charlottesville, VA (United States)); Rizwan-uddin; Dorning, J.J. Nuclear Regulatory Commission, Washington, DC (United States). Div. of Systems Technology; American Nuclear Society, La Grange Park, IL (United States); American Inst. of Chemical Engineers, New York, NY (United States); American Society of Mechanical Engineers, New York, NY (United States); Canadian Nuclear Society, Toronto, ON (Canada); European Nuclear Society (ENS), Bern (Switzerland); Atomic Energy Society of Japan, Tokyo (Japan); Japan Society of Multiphase Flow, Kyoto (Japan). Sep 1995. Grant NRC-04-90-113. (CONF-950904–Vol.4: 7. international meeting on nuclear reactor thermal hydraulics, Saratoga, NY (United States), 10-15 Sep 1995). In *Proceedings of the 7th International Meeting on Nuclear Reactor Thermal-Hydraulics NURETH-7. Sessions 17-24.* 825p. Source: OSTI; NTIS; INIS; GPO.

A simple mathematical model is developed to describe the dynamics of the nuclear-coupled thermal-hydraulics in a boiling water reactor (BWR) core. The model, which incorporates the essential features of neutron kinetics, and single-phase and two-phase thermal-hydraulics, leads to simple dynamical system comprised of a set of nonlinear ordinary differential equations (ODEs). The stability boundary is determined and plotted in the inlet-subcooling-number (enthalpy)/external-reactivity operating parameter plane. The eigenvalues of the Jacobian matrix of the dynamical system also are calculated at various steady-states (fixed points); the results are consistent with those of the direct stability analysis and indicate that a Hopf bifurcation occurs as the stability boundary in the operating parameter plane is crossed. Numerical simulations of the time-dependent, nonlinear ODEs are carried out for selected points in the operating parameter plane to obtain the actual damped and growing oscillations in the neutron number density, the channel inlet flow velocity, and the other phase variables. These indicate that the Hopf bifurcation is subcritical, hence, density wave oscillations with growing amplitude could result from a finite perturbation of the system even where the steady-state is stable. The power-flow map, frequently used by reactor operators during start-up and shut-down operation of a BWR, is mapped to

the inlet-subcooling-number/neutron-density (operating-parameter/phase-variable) plane, and then related to the stability boundaries for different fixed inlet velocities corresponding to selected points on the flow-control line. The stability boundaries for different fixed inlet subcooling numbers corresponding to those selected points, are plotted in the neutron-density/inlet-velocity phase variable plane and then the points on the flow-control line are related to their respective stability boundaries in this plane.

29462 (NUREG/CP–0142-Vol.4, pp. 2721-2737) **Analysis of two-phase flow inter-subchannel mass and momentum exchanges by the two-fluid model approach.** Ninokata, H. (Tokyo Institute of Technology (Japan)); Deguchi, A.; Kawahara, A. Nuclear Regulatory Commission, Washington, DC (United States). Div. of Systems Technology; American Nuclear Society, La Grange Park, IL (United States); American Inst. of Chemical Engineers, New York, NY (United States); American Society of Mechanical Engineers, New York, NY (United States); Canadian Nuclear Society, Toronto, ON (Canada); European Nuclear Society (ENS), Bern (Switzerland); Atomic Energy Society of Japan, Tokyo (Japan); Japan Society of Multiphase Flow, Kyoto (Japan). Sep 1995. (CONF-950904–Vol.4: 7. international meeting on nuclear reactor thermal hydraulics, Saratoga, NY (United States), 10-15 Sep 1995). In *Proceedings of the 7th International Meeting on Nuclear Reactor Thermal-Hydraulics NURETH-7. Sessions 17-24.* 825p. Source: OSTI; NTIS; INIS; GPO.

A new void drift model for the subchannel analysis method is presented for the thermohydraulics calculation of two-phase flows in rod bundles where the flow model uses a two-fluid formulation for the conservation of mass, momentum and energy. A void drift model is constructed based on the experimental data obtained in a geometrically simple inter-connected two circular channel test sections using air-water as working fluids. The void drift force is assumed to be an origin of void drift velocity components of the two-phase cross-flow in a gap area between two adjacent rods and to overcome the momentum exchanges at the phase interface and wall-fluid interface. This void drift force is implemented in the cross flow momentum equations. Computational results have been successfully compared to experimental data available including 3x3 rod bundle data.

29463 (NUREG/CP–0142-Vol.4, pp. 2785-2795) **The low-power low-pressure flow resonance in a natural circulation cooled boiling water reactor.** Hagen, T.H.J.J. van der (Delft Univ. of Technology (Netherlands)); Stekelenburg, A.J.C. Nuclear Regulatory Commission, Washington, DC (United States). Div. of Systems Technology; American Nuclear Society, La Grange Park, IL (United States); American Inst. of Chemical Engineers, New York, NY (United States); American Society of Mechanical Engineers, New York, NY (United States); Canadian Nuclear Society, Toronto, ON (Canada); European Nuclear Society (ENS), Bern (Switzerland); Atomic Energy Society of Japan, Tokyo (Japan); Japan Society of Multiphase Flow, Kyoto (Japan). Sep 1995. (CONF-950904–Vol.4: 7. international meeting on nuclear reactor thermal hydraulics, Saratoga, NY (United States), 10-15 Sep 1995). In *Proceedings of the 7th International Meeting on Nuclear Reactor Thermal-Hydraulics NURETH-7. Sessions 17-24.* 825p. Source: OSTI; NTIS; INIS; GPO.

The last few years the possibility of flow resonances during the start-up phase of natural circulation cooled BWRs has been put forward by several authors. The present paper reports on actual oscillations observed at the Dodewaard reactor, the world's only operating BWR cooled by natural circulation. In addition, results of a parameter study performed by means of a simple theoretical model are presented. The influence of relevant parameters on the resonance characteristics, being the decay ratio and the resonance frequency, is investigated and explained.

29464 (NUREG/CP–0142-Vol.4, pp. 2884-2894) **Investigations on the thermal-hydraulics of a natural circulation cooled BWR fuel assembly.** Kok, H.V. (Delft Univ. of Technology (Netherlands)); Hagen, T.H.J.J. van der; Mudde, R.F. Nuclear Regulatory Commission, Washington, DC (United States). Div. of Systems Technology; American Nuclear Society, La Grange Park, IL (United States); American Inst. of Chemical Engineers, New York, NY (United States); American Society of Mechanical Engineers, New York, NY (United States); Canadian Nuclear Society, Toronto, ON (Canada); European Nuclear Society (ENS), Bern (Switzerland); Atomic Energy Society of Japan, Tokyo (Japan); Japan Society of Multiphase Flow, Kyoto (Japan). Sep 1995. (CONF-950904–Vol.4: 7. international meeting on nuclear reactor thermal hydraulics, Saratoga, NY (United States), 10-15 Sep 1995). In *Proceedings of the 7th International Meeting on Nuclear Reactor Thermal-Hydraulics NURETH-7. Sessions 17-24.* 825p. Source: OSTI; NTIS; INIS; GPO.

A scaled natural circulation loop facility has been built after the Dodewaard Boiling Water Reactor, which is the only operating natural circulation cooled BWR in the world. The loop comprises one fuel assembly, a riser with a downcomer and a condenser with a cooling system. Freon-12 is used as a scaling liquid. This paper reports on the first measurements done with this facility. Quantities like the circulation flow, carry-under and the void-fraction have been measured as a function of power, pressure, liquid level, riser length, condensate temperature and friction factors. The behavior of the circulation flow can be understood by considering the driving force. Special attention has been paid to the carry-under, which has been shown to have a very important impact on the dynamics of a natural circulation cooled BWR.

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Refer also to citation(s) 28774, 28780, 28781, 28904, 29450, 29453, 29454, 29455, 29456, 29457, 29458, 29496, 29519, 29526, 29587, 29609, 29610, 29611, 29623, 29625, 29629, 29637, 29639, 29641, 29642, 29644, 29649, 29651, 29652, 29653, 29654, 29655, 29656, 29666, 29667, 29668, 29670, 29671, 29674, 29675, 29676, 29677, 29681, 29690, 29691, 29692, 29693, 29694, 29695, 29697, 29698, 29700, 29701, 29702, 29703, 29704, 29705, 29706, 29707, 29708, 29709, 29710, 29711, 29712, 29713, 29714, 29715, 29716, 29717, 29718, 29720, 29725, 29726, 29728, 29729, 29731, 29732, 29733, 29734, 29737, 29738, 29739, 29740, 29741, 29744, 29746, 29747, 29748, 29750, 29754, 29755, 29758, 29759, 29760, 29761, 29762, 29763, 29770, 29771, 29772, 29773, 29777, 30025, 31233

29465 (CNIC–00959) **Mechanical cleaning and TV inspection for secondary-side in PWR steam generators.** Ding Xunshen (Research Inst. of Nuclear Power Operation, Wuhan, HB (China)). China Nuclear Information Centre, Beijing, BJ (China). May 1995. 8p. (In Chinese). (RINPO–0012.). Order Number DE96601988. Source: OSTI; NTIS (US Sales Only); INIS.

The mechanical cleaning and TV inspection technology for secondary-side in steam generators of Daya Bay Nuclear Power Plant has been used for preventing the heat transfer tubes from damage caused by residues in steam generator and foreign objects between the tubes. A lancing has been used for steam generators. The high-pressure jet sent from the central lane to the inside of the bundle has two objectives: (a) the mechanical energy in the jet breaks up the deposit, and (b) the particles are then carried to the periphery of the generator, where they are collected by a water circulation system. The TV inspection consists of the inspection before and after lancing. The former includes the inspection of outer and central tube lanes, and the extraction of foreign objects; the latter includes the inspection of intertube area, outer tube lane and central tube lane, and the extraction of foreign objects. The characters of residues and foreign objects are analysed and their hazards and effects are given.

29466 (IAEA-TECDOC–803) **Strength analyses of the bubbler condenser structure of WWER-440 model 213 nuclear power plants. Reference plant: Bohunice V2 (Slovakia). Report of the IAEA Technical Co-operation Project RER/9/004 on evaluation of safety aspects of WWER-440 model 213 nuclear power plants.** International Atomic Energy Agency, Vienna (Austria). Jun 1995. 104p. Order Number DE96602727. Source: OSTI; NTIS (US Sales Only); INIS.

This publication addresses the topic of mechanical strength of the bubbler condenser applied in the WWER-440 model 213 plants and is intended to assist WWER-440/213 operators in the reassessment of the bubbler condenser performance. It is hoped that it will also be useful to anyone working in the field of WWER

safety, and in particular to experts planning, executing or reviewing studies related to the subject. Refs, figs and tabs.

29467 (KRC–92C-02) **A Study on The Corrosion Products Behavior in N/P and Establishment of Control Methods.** Lee, T.W. (Korea Electric Power Corp. (KEPCO), Taejon (Korea, Republic of). Research Center); Park, K.K.; Ku, B.M.; Lee, J.B.; Lee, K.Y.; Kim, B.S. Korea Electric Power Corp. (KEPCO), Taejon (Korea, Republic of). Research Center. 1994. 179p. (In Korean). Order Number DE96703574. Source: OSTI; NTIS (US Sales Only).

The extensive tube and support plate corrosion is being observed in PWR steam generators of domestic operating nuclear power plants. In many cases, such attack has been related to the presence of deposits and sludge on the tube support plates and tubesheet, and crevice. The ultimate goal of this project lies in development of sampling and analytical proceduress for corrosion products, evaluation of corrosion products transport, identificati- on of sources of corrosion products within the secondary system and establishment of effective countermeasures for minimizing corrosion products. As a results, the major parts of iron source throughout the secondary system was HP heater drain tank. Hıgh pH chemistry (pH:9.6->10.0) with excessive hydrazine concentration with suppresses the erosion-corrosion in the LP and HP extraction steam system, known as the major source for the corrosion products, was recommanded. (author). 9 refs., figs.

29468 (KRC–92C-J03) **Qualification Test for Chemical Cleaning of KORI Unit Two System Generators.** Kim, J.P. (Korea Electric Power Corp. (KEPCO), Taejon (Korea, Republic of). Research Center); Park, K.K.; Ku, B.M.; Park, J.K.; Chang, I.S.; Kim, W.C.; Yang, K.R.; Kim, J.S.; Chung, H.S.; Lee, E.H.; Kim, H.P.; Hwang, S.S.; Hur, D.H.; Kang, H.S. Korea Electric Power Corp. (KEPCO), Taejon (Korea, Republic of). Research Center. 1993. 206p. (In Korean). Order Number DE96703571. Source: OSTI; NTIS (US Sales Only).

In the nuclear power plants, sludge deposition in the secondary side and scaling on the tubes of steam generators often cause corrosion degradations of tubes and hinder heat transfer. Sludge deposited in the steam generators of KORI-2 primarily consists of iron oxide with very low amount of copper and lead(pb). Dents and stress corrosion cracks had been frequently found in tubes at the top of the tubesheet. Moreover, the rate of sludge deposition has been in increasing trend with years of plant operation accunulated. To resolve this problem, it was decided that the steam generators have to be chemically cleaned during the maintenance overhaul scheduled in 1993. The project included those tasks:estimation of the rate of sludge deposition, analysis of sludge composition, data base preparation for chemical cleaning, and determination of optimal process for chemical cleaning. The chemical cleaning application was performed by KEPCO in september 1993. EPRI/ SGOG Iron solvent was applied to 30 above the tubesheet using temporary chemical cleaning equipment. Sludge removal efficiency was estimated to be more than 95% and the rate of corrosion was measured far less than the limits recommended by EPRI/SGOG. (author). figs.

29469 (NUREG–1122-Rev.1) **Knowledge and abilities catalog for nuclear power plant operators: Pressurized water reactors. Revision 1.** Nuclear Regulatory Commission, Washington, DC (United States). Div. of Reactor Controls and Human Factors. Aug 1995. 500p. Sponsored by Nuclear Regulatory Commission, Washington, DC (United States). Source: OSTI; NTIS; INIS; GPO.

This document provides the basis for the development of content-valid licensing examinations for reactor operators and senior reactor operators. The examinations developed using the PWR catalog will cover those topics listed under Title 10, (ode of Federal Regulations Part 55. The PWR catalog contains approximately 5100 knowledge and ability (K/A) statements for reactor operators and senior reactor operators. The catalog is organized into six major sections: Catalog Organization; Generic Knowledge and Abilities; Plant Systems; Emergency and Abnormal Plant Evolutions; Components and Theory.

29470 (NUREG/CP–0142-Vol.4, pp. 2452-2469) **The sudden coalescene model of the boiling crisis.** Carrica, P.M. (Centro Atomico Bariloche and Instituto Balseiro, Bariloche (Argentina)); Clausse, A. Nuclear Regulatory Commission, Washington, DC (United States). Div. of Systems Technology; American Nuclear Society, La Grange Park, IL (United States); American Inst. of Chemical Engineers, New York, NY (United States); American Society of Mechanical Engineers, New York, NY (United States); Canadian Nuclear Society, Toronto, ON (Canada); European Nuclear Society (ENS), Bern (Switzerland); Atomic Energy Society of Japan, Tokyo (Japan); Japan Society of Multiphase Flow, Kyoto (Japan). Sep 1995. (CONF-950904–Vol.4: 7. international meeting on nuclear reactor thermal hydraulics, Saratoga, NY (United States), 10-15 Sep 1995). In *Proceedings of the 7th International Meeting on Nuclear Reactor Thermal-Hydraulics NURETH-7. Sessions 17-24.* 825p. Source: OSTI; NTIS; INIS; GPO.

A local two-phase flow integral model of nucleate boiling and crisis is presented. The model is based on average balances on a control volume, yielding to a set of three nonlinear differential equations for the local void fraction, bubble number density and velocity. Boiling crisis as critical heat flux is interpreted as a dynamic transition caused by the coalescence of bubbles near the heater. The theoretical dynamic model is compared with experimental results obtained for linear power ramps in a horizontal plate heater in R-113, showing an excellent qualitative agreement.

29471 (NUREG/CP–0142-Vol.4, pp. 2480-2488) **Methodology for the study of the boiling crisis in a nuclear fuel bundle.** Crecy, F. de (Commissariat a l'Energie Atomique, Grenoble (France)); Juhel, D. Nuclear Regulatory Commission, Washington, DC (United States). Div. of Systems Technology; American Nuclear Society, La Grange Park, IL (United States); American Inst. of Chemical Engineers, New York, NY (United States); American Society of Mechanical Engineers, New York, NY (United States); Canadian Nuclear Society, Toronto, ON (Canada); European Nuclear Society (ENS), Bern (Switzerland); Atomic Energy Society of Japan, Tokyo (Japan); Japan Society of Multiphase Flow, Kyoto (Japan). Sep 1995. (CONF-950904–Vol.4: 7. international meeting on nuclear reactor thermal hydraulics, Saratoga, NY (United States), 10-15 Sep 1995). In *Proceedings of the 7th International Meeting on Nuclear Reactor Thermal-Hydraulics NURETH-7. Sessions 17-24.* 825p. Source: OSTI; NTIS; INIS; GPO.

The boiling crisis is one of the phenoumena limiting the available power from a nuclear power plant. It has been widely studied for decades, and numerous data, models, correlations or tables are now available in the literature. If we now try to obtain a general view of previous work in this field, we may note that there are several ways of tackling the subject. The mechanistic models try to model the two-phase flow topology and the interaction between different sublayers, and must be validated by comparison with basic experiments, such as DEBORA, where we try to obtain some detailed informations on the two-phase flow pattern in a pure and simple geometry. This allows us to obtain better knowledge of the so-called "intrinsic effect". These models are not yet acceptable for nuclear use. As the geometry of the rod bundles and grids has a tremendous importance for the Critical Heat Flux (CHF), it is mandatory to have more precise results for a given fuel rod bundle in a restricted range of parameters: this leads to the empirical approach, using empirical CHF predictors (tables, correlations, splines, etc...). One of the key points of such a method is the obtaining local thermohydraulic values, that is to say the evaluation of the so-called "mixing effect". This is done by a subchannel analysis code or equivalent, which can be qualified on two kinds of experiments: overall flow measurements in a subchannel, such as HYDROMEL in single-phase flow or GRAZIELLA in two-phase flow, or detailed measurements inside a subchannel, such as AGATE. Nevertheless, the final qualification of a specific nuclear fuel, i.e. the synthesis of these mechanistic and empirical approaches, intrinsic and mixing effects, etc..., must be achieved on a global test such as OMEGA. This is the strategy used in France by CEA and its partners FRAMATOME and EdF.

29472 (NUREG/CP–0142-Vol.4, pp. 2489-2505) **An investigation of transition boiling mechanisms of subcooled water under forced convective conditions.** Kwang-Won, Lee; Sang-Yong, Lee. Nuclear Regulatory Commission, Washington, DC

(United States). Div. of Systems Technology; American Nuclear Society, La Grange Park, IL (United States); American Inst. of Chemical Engineers, New York, NY (United States); American Society of Mechanical Engineers, New York, NY (United States); Canadian Nuclear Society, Toronto, ON (Canada); European Nuclear Society (ENS), Bern (Switzerland); Atomic Energy Society of Japan, Tokyo (Japan); Japan Society of Multiphase Flow, Kyoto (Japan). Sep 1995. (CONF-950904–Vol.4: 7. international meeting on nuclear reactor thermal hydraulics, Saratoga, NY (United States), 10-15 Sep 1995). In *Proceedings of the 7th International Meeting on Nuclear Reactor Thermal-Hydraulics NURETH-7. Sessions 17-24.* 825p. Source: OSTI; NTIS; INIS; GPO.

A mechanistic model for forced convective transition boiling has been developed to investigate transition boiling mechanisms and to predict transition boiling heat flux realistically. This model is based on a postulated multi-stage boiling process occurring during the passage time of the elongated vapor blanket specified at a critical heat flux (CHF) condition. Between the departure from nucleate boiling (DNB) and the departure from film boiling (DFB) points, the boiling heat transfer is established through three boiling stages, namely, the macrolayer evaporation and dryout governed by nucleate boiling in a thin liquid film and the unstable film boiling characterized by the frequent touches of the interface and the heated wall. The total heat transfer rates after the DNB is weighted by the time fractions of each stage, which are defined as the ratio of each stage duration to the vapor blanket passage time. The model predictions are compared with some available experimental transition boiling data. The parametric effects of pressure, mass flux, inlet subcooling on the transition boiling heat transfer are also investigated. From these comparisons, it can be seen that this model can identify the crucial mechanisms of forced convective transition boiling, and that the transition boiling heat fluxes including the maximum heat flux and the minimum film boiling heat flux are well predicted at low qualities/high pressures near 10 bar. In future, this model will be improved in the unstable film boiling stage and generalized for high quality and low pressure situations.

29473 (NUREG/CP–0142-Vol.4, pp. 2519-2538) **A comparison of the CHF between tubes and annuli under PWR thermal-hydraulic conditions.** Herer, C. (RRAMATOME EP/TC, Paris (France)); Souyri, A.; Garnier, J. Nuclear Regulatory Commission, Washington, DC (United States). Div. of Systems Technology; American Nuclear Society, La Grange Park, IL (United States); American Inst. of Chemical Engineers, New York, NY (United States); American Society of Mechanical Engineers, New York, NY (United States); Canadian Nuclear Society, Toronto, ON (Canada); European Nuclear Society (ENS), Bern (Switzerland); Atomic Energy Society of Japan, Tokyo (Japan); Japan Society of Multiphase Flow, Kyoto (Japan). Sep 1995. (CONF-950904–Vol.4: 7. international meeting on nuclear reactor thermal hydraulics, Saratoga, NY (United States), 10-15 Sep 1995). In *Proceedings of the 7th International Meeting on Nuclear Reactor Thermal-Hydraulics NURETH-7. Sessions 17-24.* 825p. Source: OSTI; NTIS; INIS; GPO.

Critical Heat Flux (CHF) tests were carried out in three tubes with inside diameters of 8, 13, and 19.2 mm and in two annuli with an inner tube of 9.5 mm and an outer tube of 13 or 19.2 mm. All axial heat flux distributions in the test sections were uniform. The coolant fluid was Refrigerant 12 (Freon-12) under PWR thermal-hydraulic conditions (equivalent water conditions - Pressure: 7 to 20 MPa, Mass Velocity: 1000 to 6000 kg/m2/s, Local Quality: -75% to +45%). The effect of tube diameter is correlated for qualities under 15%. The change from the tube to the annulus configuration is correctly taken into account by the equivalent hydraulic diameter. Useful information is also provided concerning the effect of a cold wall in an annulus.

29474 (NUREG/CP–0142-Vol.4, pp. 2621-2635) **CHF considerations for highly moderated 100% MOX fuels PWRs.** Saphier, D. (CEA Saclay, DMT/SERMA/LETR, Gif-sur-Yvette (France)); Raymond, P. Nuclear Regulatory Commission, Washington, DC (United States). Div. of Systems Technology; American Nuclear Society, La Grange Park, IL (United States); American Inst. of Chemical Engineers, New York, NY (United States); American Society of Mechanical Engineers, New York, NY (United States); Canadian Nuclear Society, Toronto, ON (Canada); European Nuclear Society (ENS), Bern (Switzerland); Atomic Energy Society of Japan, Tokyo (Japan); Japan Society of Multiphase Flow, Kyoto (Japan). Sep 1995. (CONF-950904–Vol.4: 7. international meeting on nuclear reactor thermal hydraulics, Saratoga, NY (United States), 10-15 Sep 1995). In *Proceedings of the 7th International Meeting on Nuclear Reactor Thermal-Hydraulics NURETH-7. Sessions 17-24.* 825p. Source: OSTI; NTIS; INIS; GPO.

A feasibility study on using 100% MOX fuel in a PWR with increased moderating ratio, RMA, was initiated. In the proposed design all the parameters were chosen identical to the French 1450MW PWR, except the fuel pin diameter which was reduced to achieve higher moderating ratios, V_M/V_F, where V_M and V_F are the moderator and fuel volume respectively. Moderating ratios from 2 to 4 were considered. In the present study the thermal-hydraulic feasibility of using fuel assemblies with smaller diameter fuel pins was investigated. The major design constrain in this study was the critical heat flux (CHF). In order to maintain the fuel pin integrity under nominal operating and transient conditions, the minimum DNBR, (Departure from Nucleate Boiling Ratio given by CHF/q''_{local}, where q''_{local} is the local heat flux), has to be above a given value. The limitations of the existing CHF correlations for the present study are outlined. Two designs based on the conventional 17x17 fuel assembly and on the advanced 19x19 assembly meeting the MDNBR criteria and satisfying the control margin requirements, are proposed.

29475 (NUREG/CP–0142-Vol.4, pp. 2815-2833) **Horizontal steam generator thermal-hydraulics.** Ubra, O. (SKODA Praha Company, Prague (Czechoslovakia)); Doubek, M. Nuclear Regulatory Commission, Washington, DC (United States). Div. of Systems Technology; American Nuclear Society, La Grange Park, IL (United States); American Inst. of Chemical Engineers, New York, NY (United States); American Society of Mechanical Engineers, New York, NY (United States); Canadian Nuclear Society, Toronto, ON (Canada); European Nuclear Society (ENS), Bern (Switzerland); Atomic Energy Society of Japan, Tokyo (Japan); Japan Society of Multiphase Flow, Kyoto (Japan). Sep 1995. (CONF-950904–Vol.4: 7. international meeting on nuclear reactor thermal hydraulics, Saratoga, NY (United States), 10-15 Sep 1995). In *Proceedings of the 7th International Meeting on Nuclear Reactor Thermal-Hydraulics NURETH-7. Sessions 17-24.* 825p. Source: OSTI; NTIS; INIS; GPO.

Horizontal steam generators are typical components of nuclear power plants with pressure water reactor type VVER. Thermal-hydraulic behavior of horizontal steam generators is very different from the vertical U-tube steam generator, which has been extensively studied for several years. To contribute to the understanding of the horizontal steam generator thermal-hydraulics a computer program for 3-D steady state analysis of the PGV-1000 steam generator has been developed. By means of this computer program, a detailed thermal-hydraulic and thermodynamic study of the horizontal steam generator PGV-1000 has been carried out and a set of important steam generator characteristics has been obtained. The 3-D distribution of the void fraction and 3-D level profile as functions of load and secondary side pressure have been investigated and secondary side volumes and masses as functions of load and pressure have been evaluated. Some of the interesting results of calculations are presented in the paper.

29476 (NUREG/CP–0142-Vol.4, pp. 3153-3174) **3-D flow analyses for design of nuclear fuel spacer.** Karouta, Z. (ABB Combustion Engineering, Windsor, CT (United States)); GU, Chun-Yuan; Schoelin, B. Nuclear Regulatory Commission, Washington, DC (United States). Div. of Systems Technology; American Nuclear Society, La Grange Park, IL (United States); American Inst. of Chemical Engineers, New York, NY (United States); American Society of Mechanical Engineers, New York, NY (United States); Canadian Nuclear Society, Toronto, ON (Canada); European Nuclear Society (ENS), Bern (Switzerland); Atomic Energy Society of Japan, Tokyo (Japan); Japan Society of Multiphase Flow, Kyoto (Japan). Sep 1995. (CONF-950904–Vol.4: 7. international meeting on nuclear reactor thermal hydraulics, Saratoga, NY (United States), 10-15 Sep 1995). In *Proceedings of the 7th International*

Meeting on Nuclear Reactor Thermal-Hydraulics NURETH-7. Sessions 17-24. 825p. Source: OSTI; NTIS; INIS; GPO.

The Computational Fluid Dynamics (CFD) code, CFDS-FLOW3D, was used to develop improved fuel designs for PWR cores. It was used primarily to understand the fluid dynamics of grid spacers, the mass transfer between subchannels caused by spacers and in the long term to develop two-phase models which enable prediction of critical heat flux in PWR fuel. A single subchannel of one grid span was modeled. In this model different spacer designs with mixing devices were analyzed. A special treatment of the boundary condition was developed making use of flow symmetry to model the mass transfer between different subchannels and minimize the size of the computational model. This reduced the computational model to a fraction of a subchannel using traditional periodic boundary conditions. The Navier-Stokes equation was solved for the liquid and the flow turbulence was modeled by k-ξ turbulence model. The spacer and mixing device were treated as infinite thin surfaces in the model and a zero velocity condition and turbulent wall function were applied on each side of the thin surfaces. This approach simulated the swirl from the mixing devices well, but had the drawback of not predicting pressure drop accurately since the wake behind the plates and the acceleration effect of the spacers were ignored. CFDS-FLOW3D models with mixing devices were applied in the single-phase flow regime. Velocity profiles from the CFDS-FLOW3D models were compared to Laser Doppler Velocimeter measurements taken from the flow field downstream of spaces in a full scale, cold water test loop. The predicted axial and lateral velocity profiles were in good agreement with the measurements. The evaluation of the performance of different spacer devices was made by comparing the swirl ratio downstream of the grid spacers. It is planned to evaluate heat transfer coefficient downstream of the spaces, to implement two-phase flow models, and to model the superheated boundary layer on the surface of the fuel rod.

29477 (SAND–95-1991C) **Burnup verification measurements on spent fuel assemblies at Arkansas Nuclear One.** Ewing, R.I. Sandia National Labs., Albuquerque, NM (United States). [1995]. 7p. Sponsored by USDOE, Washington, DC (United States);Electric Power Research Inst., Palo Alto, CA (United States). DOE Contract AC04-94AL85000. (CONF-950787–84: 36. annual meeting of the Institute for Nuclear Materials Management, Palm Desert, CA (United States), 9-12 Jul 1995). Order Number DE95017891. Source: OSTI; NTIS; INIS; GPO Dep.

Burnup verification measurements have been performed using the Fork system at Arkansas Nuclear One, Units 1 and 2, operated by Energy Operations, Inc. Passive neutron and gamma-ray measurements on individual spent fuel assemblies were correlated with the reactor records for burnup, cooling time, and initial enrichment. The correlation generates an internal calibration for the system in the form of a power law determined by a least squares fit to the neutron data. The values of the exponent in the power laws were 3.83 and 4.35 for Units 1 and 2, respectively. The average deviation of the reactor burnup records from the calibration determined from the measurements is a measure of the random error in the burnup records. The observed average deviations were 2.7% and 3.5% for assemblies at Units 1 and 2, respectively, indicating a high degree of consistency in the reactor records. Two nonstandard assemblies containing neutron sources were studied at Unit 2. No anomalous measurements were observed among the standard assemblies at either Unit. The effectiveness of the Fork system for verification of reactor records is due to the sensitivity of the neutron yield to burnup, the self-calibration generated by a series of measurements, the redundancy provided by three independent detection systems, and the operational simplicity and flexibility of the design.

2103 Power Reactors, Nonbreeding, Graphite Moderated

Refer also to citation(s) 29532, 29533, 29534, 29535, 29536, 29537, 29538, 29582, 29662, 29664, 29669, 29673, 29678, 29724, 30034

29478 (JAERI-Conf–95-009, pp. 85-101) **Study of air ingress accident of an HTGR.** Hishida, Makoto (Japan Atomic Energy Research Inst., Tokai, Ibaraki (Japan). Tokai Research Establishment). Japan Atomic Energy Research Inst., Tokyo (Japan). Mar 1995. (In Japanese). (CONF-9411223–: 3. JAERI seminar on HTGR technologies, Tokai (Japan), 7-8 Nov 1994). In *Proceedings of the third JAERI seminar on HTGR technologies.* 269p. Order Number DE95776544. Source: OSTI; NTIS; INIS.

Inherent properties of high temperature gas cooled reactors (HTGR) facilitate the design of HTGRs with high degree of passive safety performances. In this context, it is very important to establish a design criteria for a passive safe function for the air ingress accident. However, it is absolutely necessary to investigate the air ingress behavior during the accident before exploring the design criteria. The present paper briefly describes major activities and results of the air ingress research in our laboratory. (author).

29479 (JAERI-Conf–95-009, pp. 143-154) **The role of the IAEA in gas-cooled reactor development and application.** Cleveland, J. (International Atomic Energy Agency, Vienna (Austria). Div. of Nuclear Power); Kupitz, J. Japan Atomic Energy Research Inst., Tokyo (Japan). Mar 1995. (CONF-9411223–: 3. JAERI seminar on HTGR technologies, Tokai (Japan), 7-8 Nov 1994). In *Proceedings of the third JAERI seminar on HTGR technologies.* 269p. Order Number DE95776544. Source: OSTI; NTIS; INIS.

The IAEA's activities in gas-cooled reactor development focus on the four technical areas which are predicted to provide advanced HTGRs with a high degree of safety, but which must be proven. These are: (a) the safe neutronic behaviour of the core, (b) reliance on ceramic coated fuel particles to retain fission products even under extreme conditions, (c) the ability to dissipate decay heat by natural heat transport mechanisms, and (d) the safe behaviour of the fuel and reactor core under chemical attack (air or water ingress). The first three are subjects of Coordinated Research Programmes (CRPs) and the last was recently addressed in an information exchange meeting. CRPs are 3 to 6 years in duration, and often involve experimental activities. CRPs allow a sharing of efforts on an international basis and benefit from the experience and expertise of researchers from the participating institutes. (J.P.N.).

29480 (JAERI-Conf–95-009, pp. 157-165) **Innovative and basic researches for high temperature technologies at HTTR.** Shiozawa, Shusaku (Japan Atomic Energy Research Inst., Oarai, Ibaraki (Japan). Oarai Research Establishment). Japan Atomic Energy Research Inst., Tokyo (Japan). Mar 1995. (In Japanese). (CONF-9411223–: 3. JAERI seminar on HTGR technologies, Tokai (Japan), 7-8 Nov 1994). In *Proceedings of the third JAERI seminar on HTGR technologies.* 269p. Order Number DE95776544. Source: OSTI; NTIS; INIS.

The HTTR is the first HTGR which is under construction at JAERI. The objectives of the HTTR are to establish basic technologies for HTGRs, to upgrade technologies for HTGRs and to conduct innovative and basic researches for high temperature technologies. The first two are concerned with HTGR developments. The last one is not necessarily for HTGR developments, but for future innovative researches which are expected to be applied to various technologies. (author).

29481 (JAERI-Conf–95-009, pp. 169-184) **Helium turbine power generation in high temperature gas reactor.** Mori, Yasuo (Tokyo Inst. of Tech. (Japan)). Japan Atomic Energy Research Inst., Tokyo (Japan). Mar 1995. (In Japanese). (CONF-9411223–: 3. JAERI seminar on HTGR technologies, Tokai (Japan), 7-8 Nov 1994). In *Proceedings of the third JAERI seminar on HTGR technologies.* 269p. Order Number DE95776544. Source: OSTI; NTIS; INIS.

This paper presents studies on the helium turbine power generator and important components in the indirect cycle of high temperature helium cooled reactor with multi-purpose use of exhaust thermal energy from the turbine. The features of this paper are, firstly the reliable estimation of adiabatic efficiencies of turbine and compressor, secondly the introduction of heat transfer enhancement by use of the surface radiative heat flux from the thin

metal plates installed in the hot helium and between the heat transfer coil rows of IHX and RHX, thirdly the use of turbine exhaust heat to produce fresh water from seawater for domestic, agricultural and marine fields, forthly a proposal of plutonium oxide fuel without a slight possibility of diversion of plutonium for nuclear weapon production and finally the investigation of GT-HTGR of large output such as 500 MWe. The study of performance of GT-HTGR reduces the result that for the reactor of 450 MWt the optimum thermal efficiency is about 43% when the turbine expansion ratio is 3.9 for the turbine efficiency of 0.92 and compressor efficiency of 0.88 and the helium temperature at the compressor inlet is 45degC. The produced amount of fresh water is about 8640 ton/day. It is made clear that about 90% of the reactor thermal output is totally used for the electric power generation in the turbine and for the multipuposed utilization of the heat from the turbine exhaust gas and compressed helium cooling seawater. The GT-Large HTGR is realized by the separation of the pressure and temperature boundaries of the pressure vessel, the increase of burning density of the fuel by 1.4 times, the extention of the nuclear core diameter and length by 1.2 times, respectively, and the enhancement of the heat flux along the nuclear fuel compact surface by 1.5 times by providing riblets with the peak in the flow direction. (J.P.N.).

29482 (JAERI-Conf–95-009, pp. 207-222) **R and D of hydrogen production by HTGRs.** Shimizu, Saburo (Japan Atomic Energy Research Inst., Tokai, Ibaraki (Japan). Tokai Research Establishment); Onuki, Kaoru; Hino, Ryutaro. Japan Atomic Energy Research Inst., Tokyo (Japan). Mar 1995. (In Japanese). (CONF-9411223–: 3. JAERI seminar on HTGR technologies, Tokai (Japan), 7-8 Nov 1994). In *Proceedings of the third JAERI seminar on HTGR technologies.* 269p. Order Number DE95776544. Source: OSTI; NTIS; INIS.

In future energy system, hydrogen energy will play a very important role as well as electric power. Global environment problems of greenhouse effect due to accumulation of carbon dioxide and acid rain due to sulfur oxides are caused mainly by consumption of a large amount of carbon-contained fossil fuels. To solve the problems, it is essential to decrease the dependence on fossil fuels and to develop both nuclear energy and renewal energy. In Japan, about 40% of primary energy is supplied to a power generation sector. Nuclear energy and renewal energy produce about 30% and 10% of electricity, respectively. Nuclear energy has a potential not only to share larger part in electricity production but also to share large energy supply in the non-electricity sector. Hydrogen production using nuclear energy is a key technology for energy supply in non-electricity sector. In order to develop hydrogen production technology as a heat utilization system of HTGRs, we are conducting studies on the following three processes. (1) Thermochemical hydrogen production process: The Iodine-sulfur process has been studied to demonstrate chemical feasibility with a laboratory-scale apparatus. Continuous hydrogen production is achieved by cyclic operation of the process. (2) High temperature electrolysis of steam: The steam electrolysis is one of the new technologies for hydrogen production. Both tubular-type and planar-type cells with solid oxide electrolyte(YSZ), are fabricated and tested to clarify features of electrolysis for further scale up. (3) Steam reforming process of natural gas: Studies are being carried out in order to lower the steam reforming temperature aiming at extensive utilization of heat energy from HTGRs. (author).

29483 (JAERI-Conf–95-009, pp. 241-260) **Progress and safety aspects in process heat utilization from nuclear systems.** Barnert, H. (Forschungszentrum Juelich GmbH (Germany)). Japan Atomic Energy Research Inst., Tokyo (Japan). Mar 1995. (CONF-9411223–: 3. JAERI seminar on HTGR technologies, Tokai (Japan), 7-8 Nov 1994). In *Proceedings of the third JAERI seminar on HTGR technologies.* 269p. Order Number DE95776544. Source: OSTI; NTIS; INIS.

Report about the Status and the Progress in the Various Programs and Projects in the Federal Republic of Germany in Process Heat Utilization from the High Temperature Reactor and on Recent Changes of the Atomic Law in the Federal Republic of Germany with Big Influence on the Safety of Nuclear Energy Technology. (author).

29484 (JAERI-Data/Code–95-005) **Thermal analysis code for test of passive cooling system by helium engineering demonstration loop (HENDEL) in-core structure test section (T_2). THANPACST2.** Takada, Shoji (Japan Atomic Energy Research Inst., Tokai, Ibaraki (Japan). Tokai Research Establishment); Suzuki, Kunihiko; Inagaki, Yoshiyuki; Ioka, Ikuo. Japan Atomic Energy Research Inst., Tokyo (Japan). Jun 1995. 211p. (In Japanese). Order Number DE96701325. Source: OSTI; NTIS; INIS.

To investigate the passive cooling features of Modular High Temperature Gas-cooled Reactor (MHTGR), a computational code-THANPACST2 : THERMAL ANALYSIS CODE FOR TEST OF PASSIVE COOLING SYSTEM BY HENDEL-T_2-, which is a two-dimensional cylindrical time-dependent flow and heat transfer code and able to calculate both the flow and temperature distribution of the components with thermal radiation, conduction and natural convection, was developed. To confirm functions of the analytical code, the analytical code -THANPACST2- was applied to the natural convection tests which simulate the loss of forced circulation accident with Helium Engineering Demonstration Loop (HENDEL) In-core Structure Test Section (T_2) being a full-scale simulation model of the core bottom structure (CBS) for High Temperature Gas-cooled Reactor (HTGR). In this report, analytical methods, outline of the analytical code, input data, programs for plot and a couple of calculated results are described. The initial conditions of transient analysis are described as follows, (1)Inlet temperature of hot helium gas: 725.4degC, mass flow rate: 3.5kg/s, Inlet temperature of cold helium gas (co-axial double tube): 146.2degC, mass flow rate: 3.655kg/s, Inlet temperature of cold helium gas (nozzle duct): 145.3degC, mass flow rate: 0.345kg/s, (2)Inlet temperature of hot helium gas: 726.9degC, mass flow rate: 1.5kg/s, Inlet temperature of cold helium gas (co-axial double tube): 145.1degC, mass flow rate: 1.129kg/s, Inlet temperature of cold helium gas (nozzle duct): 144.8degC, mass flow rate: 0.371kg/s. (author).

29485 (JAERI-Tech–94-038) **Fuel temperature prediction during high burnup HTGR fuel irradiation test. US-JAERI irradiation test for HTGR fuel.** Sawa, Kazuhiro (Japan Atomic Energy Research Inst., Tokai, Ibaraki (Japan). Tokai Research Establishment); Fukuda, Kousaku; Acharya, R. Japan Atomic Energy Research Inst., Tokyo (Japan). Jan 1995. 53p. (In Japanese). Order Number DE96701487. Source: OSTI; NTIS; INIS.

This report describes the preirradiation thermal analysis of the HRB-22 capsule designed for an irradiation test in a removable beryllium position of the High Flux Isotope Reactor(HFIR) at Oak Ridge National Laboratory. This test is being carried out under Annex 2 of the Arrangement between the U.S. Department of Energy and the Japan Atomic Energy Research Institute on Cooperation in Research and Development regarding High-Temperature Gas-cooled Reactors. The fuel used in the test is an advanced type. The advanced fuel was designed aiming at burnup of about 10%FIMA(% fissions per initial metallic atom) which was higher than that of the first charge fuel for the High Temperature Engineering Test Reactor(HTTR) and was produced in Japan. CACA-2, a heavy isotope and fission product concentration calculational code for experimental irradiation capsules, was used to determine time-dependent fission power for the fuel compacts. The Heat Engineering and Transfer in Nine Geometries(HEATING) code was used to solve the steady-state heat conduction problem. The diameters of the graphite fuel body, which contains the fuel compacts, and of the primary pressure vessel were determined such that the requirements of running the fuel compacts at an average temperature less than 1250degC and of not exceeding a maximum fuel temperature of 1350degC were met throughout the four cycles of irradiation. The detail design of the capsule was carried out based on this analysis. (author).

2104 Power Reactors, Nonbreeding, Otherwise Moderated Or Unmoderated

Refer also to citation(s) 29650

2105 Power Reactors, Breeding

Refer also to citation(s) 29127, 29583, 29634, 29635, 29645, 29682, 29683, 29684, 29685, 29686, 29687, 29688, 29689, 29722

29486 (ANL/ET/CP–82776) **Irradiation performance of U-Pu-Zr metal fuels for liquid-metal-cooled reactors.** Tsai, H.; Cohen, A.B.; Billone, M.C.; Neimark, L.A. Argonne National Lab., IL (United States). Oct 1994. 17p. Sponsored by USDOE, Washington, DC (United States). DOE Contract W-31-109-ENG-38. (CONF-950426–6: 3. international conference on nuclear engineering, Kyoto (Japan), 23-27 Apr 1995). Order Number DE95013679. Source: OSTI; NTIS; INIS; GPO Dep.

This report discusses a fuel system utilizing metallic U-Pu-Zr alloys which has been developed for advanced liquid metal-cooled reactors (LMRs). Result's from extensive irradiation testing conducted in EBR-II show a design having the following key features can achieve both high reliability and high burnup capability: a cast nominally U-20wt %Pu-10wt %Zr slug with the diameter sized to yield a fuel smear density of ≈75% theoretical density, low-swelling tempered martensitic stainless steel cladding, sodium bond filling the initial fuel/cladding gap, and an as-built plenum/fuel volume ratio of ≈1.5. The robust performance capability of this design stems primarily from the negligible loading on the cladding from either fuel/cladding mechanical interaction or fission-gas pressure during the irradiation. The effects of these individual design parameters, e.g., fuel smear density, zirconium content in fuel, plenum volume, and cladding types, on fuel element performance were investigated in a systematic irradiation experiment in EBR-II. The results show that, at the discharge burnup of ≈11 at. %, variations on zirconium content or plenum volume in the ranges tested have no substantial effects on performance. Fuel smear density, on the other hand, has pronounced but countervailing effects: increased density results in greater cladding strain, but lesser cladding wastage from fuel/cladding chemical interaction.

2106 Power Reactors, Mobile, Propulsion, Package, and Transportable

29487 (DOE/ER/12901–T1) **Fabric composite radiators for space nuclear power applications. Final report, March 1993.** Klein, A.C.; Al-Baroudi, H.; Gulshan-Ara, Z.; Kiestler, W.C.; Snuggerud, R.D.; Abdul-Hamid, S.A.; Marks, T.S. Oregon State Univ., Corvallis, OR (United States). Dept. of Nuclear Engineering. 24 Mar 1993. 134p. Sponsored by USDOE, Washington, DC (United States). DOE Contract FG02-89ER12901. (OSU-NE–9304). Order Number DE95016968. Source: OSTI; NTIS; GPO Dep.

Nuclear power systems will be required to provide much greater power levels for both civilian and defense space activities in the future than an currently needed. Limitations on the amount of usable power from radioisotope thermal generators and the limited availability of radioisotope heat source materials lead directly to the conclusion that nuclear power reactors will be needed to enhance the exploration of the solar system as well as to provide for an adequate defense. Lunar bases and travel to the Martian surface will be greatly enhanced by the use of high levels of nuclear power. Space based radar systems requiring many kilowatts of electrical power can provide intercontinental airline traffic control and defense early warning systems. Since the, figure of merit used in defining any space power system is the specific power, the decrease in die mass of any reactor system component will yield a tremendous benefit to the overall system performance. Also, since the heat rejection system of any power system can make up a large portion of the total system mass, any reduction in the mass of the heat rejection radiators will significantly affect the performance of the power system. Composite materials which combine the high strength, flexibility, and low mass characteristics of Si% based fibers with the attractive compatibility and heat transfer features of metallic foils, have been proposed for use m a number of space radiator applications. Thus, the weave of the fabric and the high strength capability of the individual fibers are combined with the high conductivity and chemical stability of a metallic liner to provide a light weight, flexible alternative to heavy, rigid, metallic radiator structural containers. The primary focus of this investigation revolves around two applications of the fabric composite materials, notably a fabric heat pipe radiator design and the Bubble Membrane Radiator concept.

29488 (DOE/SF/17787–T18) **On-Orbit Asset Management System, September 1995. Final report.** Martin Marietta Astro Space, Philadelphia, PA (United States). 10 Oct 1995. 49p. Sponsored by USDOE, Washington, DC (United States). DOE Contract AC03-89SF17787. Order Number DE96001033. Source: OSTI; NTIS; GPO Dep.

Declining budgets have prompted the need to decrease launch cost, increase satellite lifetime, and accomplish more with each satellite. This study evaluates an OOAMS system for its ability to lengthen lifetime of on-orbit assets, decrease the number of satellites required to perform a mission, increase responsiveness, and provide increased mission capability/tactical advantage. Lifetime analysis suggest that the larger satellite systems (NASA and military communication systems, surveillance satellites and earth observing satellites) would benefit most from a nuclear bimodal OOAMS. Evaluation of satellite constellations indicate that a modest reduction in the number of satellites could be realized using OOAMS if the thermal restart capability was at least ten. An OOAMS could improve the responsiveness (launching of new assets) using on-orbit reconstitution of assets. A top level utility assessment was done to address system cost issues relating to funding profiles, first unit cost, and break-even analysis. From mission capture and orbital lifetime criteria, the recommended minimum orbital altitude is 900 km. The on-orbit thermal restart capability should be increased from five to ten. Analysis of total impulse vs propellant consumed for selected missions suggests that total impulse be increased from 40 million to 48 million Newton-seconds.

29489 (LA-SUB–93-149) **Low-mass, intrinsically-hard high-temperature radiator. Final report, Phase I.** Los Alamos National Lab.. NM (United States). 15 Jun 1990. 180p. Sponsored by Department of Defense, Washington, DC (United States). DOE Contract W-7405-ENG-36. Order Number DE96000182. Source: OSTI; NTIS; GPO Dep.

Thermacore, Inc. of Lancaster, Pennsylvania has completed a Phase I SBIR program to investigate the use of layered ceramic/metal composites in the design of low-mass hardened radiators for space heat rejection systems. The program is being monitored by the Los Alamos National Laboratory (LANL) for the Strategic Defense Initiative Organization (SDIO). This effort evaluated the use of layered composites as a material to form thin-walled, vacuum leaktight heat pipes. The heat pipes would be incorporated into a large heat pipe radiator for waste heat rejection from a space nuclear power source. This approach forms an attractive alternative to metal or silicon-carbon fiber reinforced metal heat pipes by offering a combination of low mass and improved fabricability. Titanium has been shown to have a yield strength too low at 875°K to be a useful radiator material. A silicon carbide fiber reinforced titanium material appears to have sufficient strength at 875°K. but cannot be welded due to the continuous fibers, and the preferred heat pipe working fluid (potassium) has been demonstrated to be incompatible with silicon carbide at 875°K. Moreover, titanium does not appear to be acceptable for radiators subjected to anticipated laser threats. As part of this effort, Thermacore performed composite material evaluations on combinations of refractory metals and ceramic powders. Layered composite tube samples with wall thicknesses as thin as 0.012 inches were developed. Fabrication experiments were performed that demonstrated the weldability of layered composites. Two titanium/titanium diboride composite tubes were successfully fabricated into potassium heat pipes and operated at temperatures in excess of 700°C. A hybrid composite tube was also fabricated into a potassium heat pipe. The tube was composed of alternating layers of niobium-1% zirconium foil and layers of a mixture of titanium powder and titanium diboride powder.

2107 Regulation and Licensing

Refer also to citation(s) 29459, 29469, 29518, 29579, 29611, 29778, 29865, 29872, 29873

29490 (NUREG–0750-Vol.41-Index2) **Indexes to Nuclear Regulatory Commission issuances, January–June 1995. Volume 41, Index 2.** Nuclear Regulatory Commission, Washington, DC (United States). Div. of Freedom of Information and Publications Services. Sep 1995. 63p. Sponsored by Nuclear Regulatory Commission, Washington, DC (United States). Source: OSTI; NTIS; INIS; GPO.

Digests and indexes for issuances of the Commission (CLI), the Atomic Safety and Licensing Board Panel (LBP), the Administrative Law Judges (ALJ), the directors' Decisions (DD), and the Denials of Petitions for rulemaking (DPRM) are presented in this document. These digests and indexes are intended to serve as a guide to the issuances. The information elements are displayed in one or more of five separate formats arranged as follows: Case name index; digests and headers; legal citations index; subject index; and facility index.

29491 (NUREG–0750-Vol.41-No.6) **Nuclear Regulatory Commission issuances: June 1995. Volume 41, Number 6.** Nuclear Regulatory Commission, Washington, DC (United States). Div. of Freedom of Information and Publications Services. Jun 1995. 120p. Sponsored by Nuclear Regulatory Commission, Washington, DC (United States). Source: OSTI; NTIS; INIS; GPO.

This report includes the issuances received during the specified period from the Commission (CLI), the Atomic Safety and Licensing Boards (LBP), the Administrative Law Judges (ALJ), the Directors' Decisions (DD), and the Decision on Petitions for Rulemaking (DPRM). This report contains four issuances by the CLI, 5 issuances by the LBP, and 1 issuance by the DD.

2108 Economics

Refer also to citation(s) 29127, 29145

29492 (DOE/EIA–0436(95)) **World nuclear outlook 1995.** USDOE Energy Information Administration, Washington, DC (United States). Office of Coal, Nuclear, Electric and Alternate Fuels. 29 Sep 1995. 143p. Sponsored by USDOE, Washington, DC (United States). Order Number DE96000831. Source: OSTI; NTIS; GPO; INIS; GPO Dep.

As part of the EIA program to provide energy information, this analysis report presents the current status and projections through 2015 of nuclear capacity, generation, and fuel cycle requirements for all countries in the world using nuclear power to generate electricity for commercial use. It also contains information and forecasts of developments in the uranium market. Long-term projections of US nuclear capacity, generation, and spent fuel discharges for two different scenarios through 2040 are developed for the Department of Energy's Office of Civilian Radioactive Waste Management (OCRWM). In turn, the OCRWM provides partial funding for preparation of this report. The projections of uranium requirements are provided to the Organization for Economic Cooperation and Development (OECD) for preparation of the Nuclear Energy Agency/OECD report, Summary of Nuclear Power and Fuel Cycle Data in OECD Member Countries.

29493 (INIS-mf–14561, pp. 11-17) **External costs of electric power generation: are accidents adequately treated.** Hirschberg, S. (Paul Scherrer Inst. (PSI), Villigen (Switzerland)). [1995]. 125p. In *Paul Scherrer Institut annual report 1994. Annex IV: PSI nuclear energy and safety research progress report 1994.* Order Number DE96601628.

The growing environmental awareness of the public and concerns about social compatibility of large scale technology stimulate, along with current issues such as acid rain and the aftermath of the Chernobyl accident, the debate on 'external costs'. In the past, such costs have not been explicitly taken into account in the decision-making process, although they do present a burden to society. Science continuously supplies new fuel to the current debate through studies that in some cases show very large differences both in terms of approach and of numerical results. Consequently, an appropriate basis for far reaching decisions is not clearly available. This applies particularly to the treatment of the problem of rare accidents with severe consequences. The present article describes and explains the current state-of-the-art, presents results of the authors own work in the context of other contributions and underlines the most important knowledge gaps. (author) 2 figs., 1 tab., 12 refs.

29494 (INIS-mf–14588) **The uranium International trade.** Gonzalez U, L.A. Universidad Nacional Autonoma de Mexico, Mexico City (Mexico). Facultad de Ciencias Politicas y Sociales. 1993. 222p. (In Spanish). Order Number DE96602759. Source: OSTI; NTIS (US Sales Only); INIS.

The aim of this thesis is the understanding of how the present dynamic of uranium International trade is developed, the variables which fall into, the factors that are affecting and conditioning it, in order to clarify which are going to be the outlook in the future of this important resource in front of the present ecological situation and the energetic panorama of XXI Century. For this purpose, as starting point, the uranium is considered as a strategic material which importance take root in its energetic potential as alternate energy source, and for this reason in Chapter I, the general problem of raw materials, its classification and present situation in the global market is presented. In Chapter II, by means of a historical review, is explain what uranium is, how it was discovered, and how since the end of the past Century and during the last three decades of present, uranium pass of practically unknown element, to the position of a strategic raw material, which by degrees, generate an International market, owing to its utilization as a basic resource in the generation of energy. Chapter III, introduce us in the roll played by uranium, since its warlike applications until its utilization in nuclear reactors for the generation of electricity. Also is explain the reason for this change in the perception at global level. Finally, in Chapter IV we enter upon specifically in the present conditions of the International market of this mineral throughout the trends of supply and demand, the main producers, users, price dynamics, and the correlation among these economical variables and other factors of political, social and ecological nature. All of these with the purpose to found out, if there exist, a meaning of the puzzle that seems to be the uranium International trade.

22 NUCLEAR REACTOR TECHNOLOGY

29495 (KAERI-NEMAC/RR–153D/94) **A Study on the Establishment of Technical Standards of Radioactive Wastes.** Kim, Jin Wung (Korea Atomic Energy Research Institute, Taejon (Korea, Republic of)); Lee, Myung Chan; Park, Sung Won; Park, Jong Mook; Seo, Jung Moon; Kim, Kil Jung; Lee, Chan Goo; Hwang, Sin Il; Yoon, Si Tae; Jun, Young Sun; Kim, Ki Hong; Choi, Heui Joo;Korea Atomic Energy Research Inst., Taejon (Korea, Republic of). Dec 1994. 258p. (In Korean). Order Number DE96703674. Source: OSTI; NTIS (US Sales Only).

In order to secure the safety and to assure timely execution of the radioactive waste management project, NEMAC through the contract with KINS has performed the sixth period study on the establishment of technical standards related to the low-and intermediate level radioactive waste and the spent nuclear fuel interim storage facility. 54 refs., 11 figs., 15 tabs.

29496 (KRC–90N-J04) **Development of Techniques for Reducing PWR Primary Coolant System Dose Rate.** Song, M.J. (Korea Electric Power Corp. (KEPCO), Taejon (Korea, Republic of). Research Center); Chung, Y.G.; Kang, D.W.; Sin, S.W.; Son, S.H.; Kim, H.K.; Ha, T.K.; Hong, Y.W.; Sin, B.K.; Im, G.S.; Yang, K.R.; No, G.H.; Han, J.H.; Chung, Y.W.; Lee, D.H.; ParKorea Electric Power Corp. (KEPCO), Taejon (Korea, Republic of). Research Center. 1993. 396p. (In Korean). Order Number DE96703603. Source: OSTI; NTIS (US Sales Only).

In an effort to develop techniques for reducing primary circuit dose rate due to high pH operation and a fine filtration system, integral investigation including theoretical, experimental and in-file data approaches have been made to study high pH operation effects on the radiation source buildup and material integrity. As a theoretical approach, a computer program COTRAN (COrrosion product TRANsport) code has been developed which can evaluate the corrosion product behaviors and predict radiation dose rate under the specific high pH operation conditions. The COTRAN was applied to MIT PCCL and its results were compared with PCCL

data. Evaluation on the operation data of the 10th and the 11th cycles by using the COTRAN code has proved the long term occupational radiation exposure reduction effect. As an experimental investigation, long-term autoclave corrosion tests have been carried out on Zircaloy-4 fuel cladding in lithiated/borated solution at 350° and 165 bar to study the effect of Li/B content on corrosion behaviors of Zircaloy fuel cladding. From the experiment, a very important investigation has been obtained which can be remarkably applicable to the prediction of oxidation rate of in-file Zircaloy fuel cladding at any content of Li/B in Primary coolant water. The oxide thickness or weight gain which was measured at a beginning of corrosion acceleration decreased with increase of Li content in Li/B solution of a pH range of 6.9-7.4. Corrosion tests on Inconel 600 S/G tubing showed negligible effects on the PWSCC of Inconel tubing. As in-file data approach, characterization of crud samples taken Kori-1 primary coolant and S/G tubing and channel heads shows a gradual decrease of radioactivities due to the high pH operation. (author). 107 refs.

29497 (NUREG–0304-Vol.20-No.2) **Regulatory and technical reports (abstract index journal). Volume 20, No. 2: Compilation for second quarter April–June 1995.** Nuclear Regulatory Commission, Washington, DC (United States). Div. of Freedom of Information and Publications Services. Sep 1995. 40p. Sponsored by Nuclear Regulatory Commission, Washington, DC (United States). Source: OSTI; NTIS; INIS; GPO.

This compilation consists of bibliographic data and abstracts for the formal regulatory and technical reports issued by the U.S. Nuclear Regulatory Commission (NRC) Staff and its contractors. It is NRC's intention to publish this compilation quarterly and to cumulate it annually.

2201 Theory and Calculation

Refer also to citation(s) 29631, 29632

29498 (LA-UR–95-1886) **Testing of the ENDF/B-VI neutron data library ENDF60 for use with MCNP™.** Frankle, S.C.; MacFarlane, R.E. Los Alamos National Lab., NM (United States). [1995]. 9p. Sponsored by USDOE, Washington, DC (United States). DOE Contract W-7405-ENG-36. (CONF-9509100–28: 5. international conference on nuclear criticality safety, Albuquerque, NM (United States), 17-22 Sep 1995). Order Number DE95015199. Source: OSTI; NTIS; INIS; GPO Dep.

The continuous-energy neutron data library ENDF60, for use with the Monte Carlo N-Particle radiation transport code MCNP4A, was released in the fall of 1994. It is comprised of 124 nuclide data files based on the ENDF/B-Vi evaluations through Release 2. Forty-eight percent of these materials are new or modified evaluations, while the balance are translations from ENDF/B-V. The new evaluations include most of the important materials for criticality safety calculations, and include significant enhancements such as more isotopic evaluations, better resonance-range representations, and the new correlated energy-angle distributions for emitted particles. As part of the overall quality assurance testing of the ENDF60 library, calculations for well known benchmark assemblies were performed. The results of these calculations help the user to know how the combination of ENDF60 and MCNP4A will perform for real problems.

29499 (LA-UR–95-1987) **Estimation and interpretation of k_{eff} confidence intervals in MCNP.** Urbatsch, T.J. (Michigan Univ., Ann Arbor, MI (United States). Dept. of Nuclear Engineering); Forster, R.A.; Prael, R.E.; Beckman, R.J. Los Alamos National Lab., NM (United States). [1995]. 8p. Sponsored by USDOE, Washington, DC (United States). DOE Contract W-7405-ENG-36. (CONF-9509100–26: 5. international conference on nuclear criticality safety, Albuquerque, NM (United States), 17-22 Sep 1995). Order Number DE95015260. Source: OSTI; NTIS; INIS; GPO Dep.

MCNP has three different, but correlated, estimators for Calculating k_{eff} in nuclear criticality calculations: collision, absorption, and track length estimators. The combination of these three estimators, the three-combined k_{eff} estimator, is shown to be the best k_{eff} estimator available in MCNP for estimating k_{eff} confidence intervals. Theoretically, the Gauss-Markov Theorem provides a solid foundation for MCNP's three-combined estimator. Analytically, a statistical study, where the estimates are drawn using a known covariance matrix, shows that the three-combined estimator is superior to the individual estimator with the smallest variance. The importance of MCNP's batch statistics is demonstrated by an investigation of the effects of individual estimator variance bias on the combination of estimators, both heuristically with the analytical study and empirically with MCNP.

29500 (LA-UR–95-1988) **The use of particle tracks in problem analysis.** Van Riper, K.A.; McKinney, G.W.; Urbatsch, T. Los Alamos National Lab., NM (United States). [1995]. 8p. Sponsored by USDOE, Washington, DC (United States). DOE Contract W-7405-ENG-36. (CONF-9509100–27: 5. international conference on nuclear criticality safety, Albuquerque, NM (United States), 17-22 Sep 1995). Order Number DE95013094. Source: OSTI; NTIS; GPO Dep.

The visualization of the microscopic phenomena in a Monte Carlo simulation can improve the understanding of the problem and provide an important check on the model definition and execution. The paths, or tracks, of a sample of the Monte Carlo particles show how fission source neutrons migrate from one generation to another. The location of fission source neutrons and interactions can be shown by event markers. This new visualization is available for the Monte Carlo n-particle code MCNP due to the addition of fission source neutrons, tagged by cycle number, to the particle track (PTRAC) data. We report here on the use of this and similar information for the analysis and illustration of criticality calculations.

29501 (LA-UR–95-2069) **Criticality benchmark results for the ENDF60 library with MCNP™.** Keen, N.D.; Frankle, S.C.; MacFarlane, R.E. Los Alamos National Lab., NM (United States). [1995]. 5p. Sponsored by USDOE, Washington, DC (United States). DOE Contract W-7405-ENG-36. (CONF-951006–20: Winter meeting of the American Nuclear Society, San Francisco, CA (United States), 29 Oct - 1 nov 1995). Order Number DE95015306. Source: OSTI; NTIS; INIS; GPO Dep.

The continuous-energy neutron data library ENDF60, for use with the Monte Carlo N-Particle radiation transport code MCNP4A, was released in the fall of 1994. The ENDF60 library is comprised of 124 nuclide data files based on the ENDF/B-VI (B-VI) evaluations through Release 2. Fifty-two percent of these B-VI evaluations are translations from ENDF/B-V (B-V). The remaining forty-eight percent are new evaluations which have sometimes changed significantly. Among these changes are greatly increased use of isotopic evaluations, more extensive resonance-parameter evaluations, and energy-angle correlated distributions for secondary particles. In particular, the upper energy limit for the resolved resonance region of ^{235}U, ^{238}U and ^{239}Pu has been extended from 0.082, 4.0, and 0.301 keV to 2..25, 10.0, and 2.5 keV respectively. As regulatory oversight has advanced and performing critical experiments has become more difficult, there has been an increased reliance on computational methods. For the criticality safety community, the performance of the combined transport code and data library is of interest. The purpose of this abstract is to provide benchmarking results to aid the user in determining the best data library for their application.

2202 Components and Accessories

Refer also to citation(s) 29467, 29575, 29576, 29581, 29593, 29594, 29595, 29596, 29597, 29598, 29599, 29600, 29601, 29602, 29603, 29606, 29607, 29608, 29612, 29613, 29614, 29615, 29616, 29617, 29618, 29619, 29620, 29621, 29622, 29626, 29630, 29633, 29640, 29646, 29647, 29648, 29696, 29699, 29751, 29752, 29756, 29757, 29764, 29774, 30342

29502 (CONF-9506266–1) **Microstructural investigations of as-fabricated, long-term thermally aged and neutron irradiated RPV materials: An atom probe study.** Pareige, P.J.; Miller, M.K.; Stoller, R.E. Oak Ridge National Lab., TN (United States). [1995]. 16p. Sponsored by USDOE, Washington, DC (United States);Nuclear Regulatory Commission, Washington, DC (United States);Oak Ridge Inst. for Science and Education, TN (United

States). DOE Contract AC05-84OR21400. From International workshop on aged and decommissioned material collection and testing for structural integrity purposes; Mol (Belgium); 27-28 Jun 1995. Order Number DE95017442. Source: OSTI; NTIS; GPO Dep.

Atom probe field ton microscopy (APFIM) investigations of the microstructure of as-fabricated, long-term thermally aged (~100,000h. at 540°F (282°C)) and neutron-irradiated (6.6×10^{18} and 3.47×10^{19} n cm^{-2} (E>1 MeV) at ~550°F (288°C)) surveillance materials from commercial reactor pressure vessel steels were performed This combination of materials and conditions permitted the investigation of potential thermal aging effects as well as the neutron-induced effects. The microstructural study focused on the quantification of the matrix chemistry and the detection and characterization of radiation-induced precipitates. The APFIM results indicate that there was no microstructural evolution after a long term-thermal exposure in weld (0.28 wt% Cu), plate (0.13 wt% Cu) or forging (0.02 wt% Cu) materials. Conversely, matrix depletion of copper and phosphorus solutes and the presence of Cu. P, Ni, Mn and Si rich clusters were observed in the neutron-irradiated weld material. These APFIM comparisons of materials in all three conditions are consistent with the measured change in mechanical properties (transition temperature shift).

29503 (INIS-mf–14561, pp. 107-113) **SULZER containment venting filter verification experiments.** Guentay, S. (Paul Scherrer Inst. (PSI), Villigen (Switzerland)); Suckow, D.; Leute, H.; Knuchel, H.; Schuett, H.; Winkler, P. [1995]. 125p. In *Paul Scherrer Institut annual report 1994. Annex IV: PSI nuclear energy and safety research progress report 1994.* Order Number DE96601628.

A series of aerosol tests was performed at the Laboratory for Safety and Accident Research (LSU) at the Paul Scherrer Institut (PSI) to verify the aerosol retention efficiency of the Advanced Sulzer Containment Venting Filter System. The tests determined how radioactive aerosol particles, which were simulated by use of inactive tin dioxide particles, would be filtered under conditions more extreme than those expected to occur inside a light water reactor containment during a severe accident. The particles were generated using an evaporation and condensation technique. The filter system, tested at the design conditions, was shown to achieve minimum decontamination factors of 48700 and 195000 respectively, depending on the filter type. A special test indicated that aerosol release from the filter system, due to resuspension from highly contaminated filter water, did not take place. The main conclusions of the program and the results of the tests conducted between September 1993 and August 1994 are presented. (author) 7 figs., 2 tabs., 1 ref.

29504 (NUREG/CP–0142-Vol.1, pp. 111-130) **Characterization of non equilibrium effects on high quality critical flows.** Camelo, E. (Commissariat a l Energie Atomique, Grenoble (France)); Lemonnier, H.; Ochterbeck, J. Nuclear Regulatory Commission, Washington, DC (United States). Div. of Systems Technology; American Nuclear Society, La Grange Park, IL (United States); American Inst. of Chemical Engineers, New York, NY (United States); American Society of Mechanical Engineers, New York, NY (United States); Canadian Nuclear Society, Toronto, ON (Canada); Japan Society of Multiphase Flow, Kyoto (Japan). Sep 1995. (CONF-950904–Vol.1: 7. international meeting on nuclear reactor thermal hydraulics, Saratoga, NY (United States), 10-15 Sep 1995). In *Proceedings of the 7th International Meeting on Nuclear Reactor Thermal-Hydraulics NURETH-7. Volume 1, Sessions 1-5.* 862p. Source: OSTI; NTIS; INIS; GPO.

The appropriate design of various pieces of safety equipment such as relief systems, relies on the accurate description of critical flow phenomena. Most of the systems of industrial interest are willing to be described by one-dimensional area-averaged models and a large fraction of them involves multi-component high gas quality flows. Within these circumstances, the flow is very likely to be of an annular dispersed nature and its description by two-fluid models requires various closure relations. Among the most sensitive closures, there is the interfacial area and the liquid entrained fraction. The critical flowrate depends tremendously on the accurate description of the non equilibrium which results from the correctness of the closure equations. In this study, two-component flows are emphasized and non equilibrium results mainly form the differences in the phase velocities. It is therefore of the utmost importance to have reliable data to characterize non equilibrium phenomena and to assess the validity of the closure models. A comprehensive description of air-water nozzle flows, with emphasis on the effect of the nozzle geometry, has been undertaken and some of the results are presented here which helps understanding the overall flow dynamics. Besides the critical flowrate, the presented material includes pressure profiles, droplet size and velocity, liquid film flowrate and liquid film thickness.

29505 (NUREG/CP–0142-Vol.4, pp. 2470-2479) **The role of heater thermal response in reactor thermal limits during oscillartory two-phase flows.** Ruggles, A.E. (Univ. of Tennessee, Knoxville, TN (United States)); Brown, N.W.; Vasil'ev, A.D.; Wendel, M.W. Nuclear Regulatory Commission, Washington, DC (United States). Div. of Systems Technology; American Nuclear Society, La Grange Park, IL (United States); American Inst. of Chemical Engineers, New York, NY (United States); American Society of Mechanical Engineers, New York, NY (United States); Canadian Nuclear Society, Toronto, ON (Canada); European Nuclear Society (ENS), Bern (Switzerland); Atomic Energy Society of Japan, Tokyo (Japan); Japan Society of Multiphase Flow, Kyoto (Japan). Sep 1995. (CONF-950904–Vol.4: 7. international meeting on nuclear reactor thermal hydraulics, Saratoga, NY (United States), 10-15 Sep 1995). In *Proceedings of the 7th International Meeting on Nuclear Reactor Thermal-Hydraulics NURETH-7. Sessions 17-24.* 825p. Source: OSTI; NTIS; INIS; GPO.

Analytical and numerical investigations of critical heat flux (CHF) and reactor thermal limits are conducted for oscillatory two-phase flows often associated with natural circulation conditions. It is shown that the CHF and associated thermal limits depend on the amplitude of the flow oscillations, the period of the flow oscillations, and the thermal properties and dimensions of the heater. The value of the thermal limit can be much lower in unsteady flow situations than would be expected using time average flow conditions. It is also shown that the properties of the heater strongly influence the thermal limit value in unsteady flow situations, which is very important to the design of experiments to evaluate thermal limits for reactor fuel systems.

29506 (NUREG/CP–0142-Vol.4, pp. 2583-2607) **A comparison of critical heat flux in tubes and bilaterally heated annuli.** Doerffer, S. (Univ. of Ottawa (Canada)); Groeneveld, D.C.; Cheng, S.C. Nuclear Regulatory Commission, Washington, DC (United States). Div. of Systems Technology; American Nuclear Society, La Grange Park, IL (United States); American Inst. of Chemical Engineers, New York, NY (United States); American Society of Mechanical Engineers, New York, NY (United States); Canadian Nuclear Society, Toronto, ON (Canada); European Nuclear Society (ENS), Bern (Switzerland); Atomic Energy Society of Japan, Tokyo (Japan); Japan Society of Multiphase Flow, Kyoto (Japan). Sep 1995. (CONF-950904–Vol.4: 7. international meeting on nuclear reactor thermal hydraulics, Saratoga, NY (United States), 10-15 Sep 1995). In *Proceedings of the 7th International Meeting on Nuclear Reactor Thermal-Hydraulics NURETH-7. Sessions 17-24.* 825p. Source: OSTI; NTIS; INIS; GPO.

This paper examines the critical heat flux (CHF) behaviour for annular flow in bilaterally heated annuli and compares it to that in tubes and unilaterally heated annuli. It was found that the differences in CHF between bilaterally and unilaterally heated annuli or tubes strongly depend on pressure and quality. the CHF in bilaterally heated annuli can be predicted by tube CHF prediction methods for the simultaneous CHF occurrence at both surfaces, and the following flow conditions: pressure 7-10 MPa, mass flux 0.5-4.0 Mg/m^2s and critical quality 0.23-0.9. The effect on CHF of the outer-to-inner surface heat flux ratio, was also examined. The prediction of CHF for bilaterally heated annuli was based on the droplet-diffusion model proposed by Kirillov and Smogalev. While their model refers only to CHF occurrence at the inner surface, we extended it to cases where CHF occurs at the outer surface, and simultaneously at both surfaces, thus covering all cases of CHF occurrence in bilaterally heated annuli. From the annuli CHF data of Becker and Letzter, we derived empirical functions required by the model. the proposed equations provide good accuracy for the CHF

data used in this study. Moreover, the equations can predict conditions at which CHF occurs simultaneously at both surfaces. Also, this method can be used for cases with only one heated surface.

29507 (NUREG/CP–0142-Vol.4, pp. 2636-2653) **General correlation for prediction of critical heat flux ratio in water cooled channels.** Pernica, R.; Cizek, J. Nuclear Regulatory Commission, Washington, DC (United States). Div. of Systems Technology; American Nuclear Society, La Grange Park, IL (United States); American Inst. of Chemical Engineers, New York, NY (United States); American Society of Mechanical Engineers, New York, NY (United States); Canadian Nuclear Society, Toronto, ON (Canada); European Nuclear Society (ENS), Bern (Switzerland); Atomic Energy Society of Japan, Tokyo (Japan); Japan Society of Multiphase Flow, Kyoto (Japan). Sep 1995. (CONF-950904–Vol.4: 7. international meeting on nuclear reactor thermal hydraulics, Saratoga, NY (United States), 10-15 Sep 1995). In *Proceedings of the 7th International Meeting on Nuclear Reactor Thermal-Hydraulics NURETH-7. Sessions 17-24.* 825p. Source: OSTI; NTIS; INIS; GPO.

The paper present the general empirical Critical Heat Flux Ration (CHFR) correlation which is valid for vertical water upflow through tubes, internally heated concentric annuli and rod bundles geometries with both wide and very tight square and triangular rods lattices. The proposed general PG correlation directly predicts the CHFR, it comprises axial and radial non-uniform heating, and is valid in a wider range of thermal hydraulic conditions than previously published critical heat flux correlations. The PG correlation has been developed using the critical heat flux Czech data bank which includes more than 9500 experimental data on tubes, 7600 data on rod bundles and 713 data on internally heated concentric annuli. Accuracy of the CHFR prediction, statistically assessed by the constant dryout conditions approach, is characterized by the mean value nearing 1.00 and the standard deviation less than 0.06. Moverover, a subchannel form of the PG correlations is statistically verified on Westinghouse and Combustion Engineering rod bundle data bases, i.e. more than 7000 experimental CHF points of Columbia University data bank were used.

29508 (NUREG/CP–0142-Vol.4, pp. 2738-2761) **Large-scale transport across narrow gaps in rod bundles.** Guellouz, M.S. (Univ. of Ottawa (Canada)); Tavoularis, S. Nuclear Regulatory Commission, Washington, DC (United States). Div. of Systems Technology; American Nuclear Society, La Grange Park, IL (United States); American Inst. of Chemical Engineers, New York, NY (United States); American Society of Mechanical Engineers, New York, NY (United States); Canadian Nuclear Society, Toronto, ON (Canada); European Nuclear Society (ENS), Bern (Switzerland); Atomic Energy Society of Japan, Tokyo (Japan); Japan Society of Multiphase Flow, Kyoto (Japan). Sep 1995. (CONF-950904–Vol.4: 7. international meeting on nuclear reactor thermal hydraulics, Saratoga, NY (United States), 10-15 Sep 1995). In *Proceedings of the 7th International Meeting on Nuclear Reactor Thermal-Hydraulics NURETH-7. Sessions 17-24.* 825p. Source: OSTI; NTIS; INIS; GPO.

Flow visualization and how-wire anemometry were used to investigate the velocity field in a rectangular channel containing a single cylindrical rod, which could be traversed on the centreplane to form gaps of different widths with the plane wall. The presence of large-scale, quasi-periodic structures in the vicinity of the gap has been demonstrated through flow visualization, spectral analysis and space-time correlation measurements. These structures are seen to exist even for relatively large gaps, at least up to W/D=1.350 (W is the sum of the rod diameter, D, and the gap width). The above measurements appear to compatible with the field of a street of three-dimensional, counter-rotating vortices, whose detailed structure, however, remains to be determined. The convection speed and the streamwise spacing of these vortices have been determined as functions of the gap size.

29509 (NUREG/CP–0142-Vol.4, pp. 2916-2923) **Water hammer phenomena occurring in nuclear power installations while filling horizontal pipe containing saturated steam with liquid.** Selivanov, Y.F. (Institute of Physics and Power Engineering, Obninsk (Russian Federation)); Kirillov, P.L.; Yefanov, A.D. Nuclear Regulatory Commission, Washington, DC (United States). Div. of Systems Technology; American Nuclear Society, La Grange Park, IL (United States); American Inst. of Chemical Engineers, New York, NY (United States); American Society of Mechanical Engineers, New York, NY (United States); Canadian Nuclear Society, Toronto, ON (Canada); European Nuclear Society (ENS), Bern (Switzerland); Atomic Energy Society of Japan, Tokyo (Japan); Japan Society of Multiphase Flow, Kyoto (Japan). Sep 1995. (CONF-950904–Vol.4: 7. international meeting on nuclear reactor thermal hydraulics, Saratoga, NY (United States), 10-15 Sep 1995). In *Proceedings of the 7th International Meeting on Nuclear Reactor Thermal-Hydraulics NURETH-7. Sessions 17-24.* 825p. Source: OSTI; NTIS; INIS; GPO.

The potentiality of the water hammer occurrence in nuclear reactor loop components has been considered under the conditions of filling a steam-containing pipeline leg involving horizontal and vertical sections with liquid subcooled to the saturation temperature. As a result of free discharging from the tank, the liquid enters the horizontal pipeline. When the liquid slug formation in the pipeline is fulfilled. The pressure drop being occurred in steam flowing along the pipelines causes the liquid slug to move to the pipeline inlet. When the liquid slug decelerates, a water hammer occurs. This mechanism of water hammer occurrence is tested by experiments. The regimes of the occurrence of multiple considerable water hammers were identified.

29510 (NUREG/CP–0142-Vol.4, pp. 3073-3082) **Turbulent mixed convection in vertical and inclined flat channels with aiding flows.** Poskas, P.; Vilemas, J.; Adomaitis, J.E.; Bartkus, G. Nuclear Regulatory Commission, Washington, DC (United States). Div. of Systems Technology; American Nuclear Society, La Grange Park, IL (United States); American Inst. of Chemical Engineers, New York, NY (United States); American Society of Mechanical Engineers, New York, NY (United States); Canadian Nuclear Society, Toronto, ON (Canada); European Nuclear Society (ENS), Bern (Switzerland); Atomic Energy Society of Japan, Tokyo (Japan); Japan Society of Multiphase Flow, Kyoto (Japan). Sep 1995. (CONF-950904–Vol.4: 7. international meeting on nuclear reactor thermal hydraulics, Saratoga, NY (United States), 10-15 Sep 1995). In *Proceedings of the 7th International Meeting on Nuclear Reactor Thermal-Hydraulics NURETH-7. Sessions 17-24.* 825p. Source: OSTI; NTIS; INIS; GPO.

This paper presents an experimental study of turbulent mixed convection heat transfer for aiding flows in a vertical (ϕ=90°), inclined (ϕ=60°,30°), and horizontal (ϕ=0°) flat channels with symmetrical heating and a ratio of height h to width b of about 1:10 and with length about 4 m (x/2h about 44). The study covered Re from $4x10^3$ to $5x10^4$ and Gr_q from $5x10^7$to $3x10^{10}$. For the upper wall, a region of impaired heat transfer was found for all angular positions (from vertical to horizontal) and for bottom wall the augmentation of heat transfer in comparison to forced convection was revealed in the region of ϕ=0°-60°. Different characteristic buoyancy parameters were found for regions of impaired and enhanced heat transfer. General relations are suggested to predict the heat transfer for fully-developed-flow conditions and different angular positions.

29511 (NUREG/CP–0142-Vol.4, pp. 3120-3141) **Turbulence prediction in two-dimensional bundle flows using large eddy simulation.** Ibrahim, W.A. (Texas A&M Univ., College Station, TX (United States)); Hassan, Y.A. Nuclear Regulatory Commission, Washington, DC (United States). Div. of Systems Technology; American Nuclear Society, La Grange Park, IL (United States); American Inst. of Chemical Engineers, New York, NY (United States); American Society of Mechanical Engineers, New York, NY (United States); Canadian Nuclear Society, Toronto, ON (Canada); European Nuclear Society (ENS), Bern (Switzerland); Atomic Energy Society of Japan, Tokyo (Japan); Japan Society of Multiphase Flow, Kyoto (Japan). Sep 1995. (CONF-950904–Vol.4: 7. international meeting on nuclear reactor thermal hydraulics, Saratoga, NY (United States), 10-15 Sep 1995). In *Proceedings of the 7th International Meeting on Nuclear Reactor Thermal-Hydraulics NURETH-7. Sessions 17-24.* 825p. Source: OSTI; NTIS; INIS; GPO.

Turbulent flow is characterized by random fluctuations in the fluid velocity and by intense mixing of the fluid. Due to velocity fluctuations, a wide range of eddies exists in the flow field. Because these

eddies carry mass, momentum, and energy, this enhanced mixing can sometimes lead to serious problems, such as tube vibrations in many engineering systems that include fluid-tube bundle combinations. Nuclear fuel bundles and PWR steam generators are existing examples in nuclear power plants. Fluid-induced vibration problems are often discovered during the operation of such systems because some of the fluid-tube interaction characteristics are not fully understood. Large Eddy Simulation, incorporated in a three dimensional computer code, became one of the promising techniques to estimate flow turbulence, predict and prevent of long-term tube fretting affecting PWR steam generators. the present turbulence investigations is a step towards more understanding of fluid-tube interaction characteristics by comparing the tube bundles with various pitch-to-diameter ratios were performed. Power spectral densities were used for comparison with experimental data. Correlations, calculations of different length scales in the flow domain and other important turbulent-related parameters were calculated. Finally, important characteristics of turbulent flow field were presented with the aid of flow visualization with tracers impeded in the flow field.

29512 (NUREG/CP–0142-Vol.4, pp. 3142-3152) **Statistical parameter characteristics of gas-phase fluctuations for gas-liquid intermittent flow.** Matsui, G. (Univ. of Tsukuba (Japan)); Monji, H.; Takaguchi, M. Nuclear Regulatory Commission, Washington, DC (United States). Div. of Systems Technology; American Nuclear Society, La Grange Park, IL (United States); American Inst. of Chemical Engineers, New York, NY (United States): American Society of Mechanical Engineers, New York, NY (United States); Canadian Nuclear Society, Toronto, ON (Canada); European Nuclear Society (ENS), Bern (Switzerland); Atomic Energy Society of Japan, Tokyo (Japan); Japan Society of Multiphase Flow, Kyoto (Japan). Sep 1995. (CONF-950904–Vol.4: 7. international meeting on nuclear reactor thermal hydraulics, Saratoga, NY (United States), 10-15 Sep 1995). In *Proceedings of the 7th International Meeting on Nuclear Reactor Thermal-Hydraulics NURETH-7. Sessions 17-24.* 825p. Source: OSTI; NTIS; INIS; GPO.

This study deals with theoretical analysis on the general behaviour of statistical parameters of gas-phase fluctuations and comparison of statistical parameter characteristics for the real void fraction fluctuations measured with those for the wave form modified the real fluctuations. In order to investigate the details of the relation between the behavior of the statistical parameters in real intermittent flow and analytical results obtained from information on the real flow, the distributions of statistical parameters for general fundamental wave form of gas-phase fluctuations are discussed in detail. By modifying the real gas-phase fluctuations to a trapezoidaly wave, the experimental results can be directly compared with the analytical results. The analytical results for intermittent flow show that the wave form parameter, and the total amplitude of void fraction fluctuations, affects strongly on the statistical parameter characteristics. The comparison with experiment using nitrogen gas-water intermittent flow suggests that the parameters of skewness and excess may be better as indicators of flow pattern. That is, the macroscopic nature of intermittent flow can be grasped by the skewness and the excess, and the detailed flow structure may be described by the mean and the standard deviation.

29513 (NUREG/CP–0142-Vol.4, pp. 3197-3217) **Correlation of critical heat flux data for uniform tubes.** Jafri, T. (Columbia Univ., New York, NY (United States)); Dougherty, T.J.; Yang, B.W. Nuclear Regulatory Commission, Washington, DC (United States). Div. of Systems Technology; American Nuclear Society, La Grange Park, IL (United States); American Inst. of Chemical Engineers, New York, NY (United States); American Society of Mechanical Engineers, New York, NY (United States); Canadian Nuclear Society, Toronto, ON (Canada); European Nuclear Society (ENS), Bern (Switzerland); Atomic Energy Society of Japan, Tokyo (Japan); Japan Society of Multiphase Flow, Kyoto (Japan). Sep 1995. (CONF-950904–Vol.4: 7. international meeting on nuclear reactor thermal hydraulics, Saratoga, NY (United States), 10-15 Sep 1995). In *Proceedings of the 7th International Meeting on Nuclear Reactor Thermal-Hydraulics NURETH-7. Sessions 17-24.* 825p. Source: OSTI; NTIS; INIS; GPO.

A data base of more than 10,000 critical heat flux (CHF) data points has been compiled and analyzed. Two regimes of CHF are observed which will be referred to as the high CHF regime and the low CHF regime. In the high CHF regime, for pressures less than 110 bar, CHF (q_c) is a determined by local conditions and is adequately represented by $q_c = (1.2/D^{1/2})\ \exp[-\gamma(GX_t)^{1/2}]$ where the parameter γ is an increasing function of pressure only, X_t the true mass fraction of steam, and all units are metric but the heat flux is in MWm^{-2}. A simple kinetic model has been developed to estimate X_t as a function of G, X, X_i, and X_O, where X_i is the inlet quality and X_O represents the quality at the Onset of Significant Vaporization (OSV) which is estimated from the Saha-Zuber (S-Z) correlation. The model is based on a rate equation for vaporization suggested by, and consistent with, the S-Z correlation and contains no adjustable parameters. When $X_i < X_O$ (both negative), X_t is independent of X_i and is a function of local variables only. For $X_i > X_O$, X_t depends on X_i, a nonlocal variable, and, in this case, CHF, although determined by local conditions, obeys a nonlocal correlation. This model appears to be satisfactory for pressures less than 110 bar, where the S-Z correlation is known to be reliable. Above 110 bar the method of calculating X_O, and consequently X_t, appears to fail, so this approach can not be applied to high pressure CHF data. Above 35 bar, the bulk of the available data lies in the high CHF regime while, at pressures less than 35 bar, almost all of the available data lie in the low CHF regime and appear to be nonlocal.

29514 (NUREG/CP–0142-Vol.4, pp. 3218-3232) **A model of film boiling in the presence of electric fields.** Carrica, P.M. (Centro Atomico Bariloche and Instituto Balseiro, Barilochi (Argentina)); Masson, V.; Clausse, A. Nuclear Regulatory Commission, Washington, DC (United States). Div. of Systems Technology; American Nuclear Society, La Grange Park, IL (United States); American Inst. of Chemical Engineers, New York, NY (United States); American Society of Mechanical Engineers, New York, NY (United States); Canadian Nuclear Society, Toronto, ON (Canada); European Nuclear Society (ENS), Bern (Switzerland); Atomic Energy Society of Japan, Tokyo (Japan); Japan Society of Multiphase Flow, Kyoto (Japan). Sep 1995. (CONF-950904–Vol.4: 7. international meeting on nuclear reactor thermal hydraulics, Saratoga, NY (United States), 10-15 Sep 1995). In *Proceedings of the 7th International Meeting on Nuclear Reactor Thermal-Hydraulics NURETH-7. Sessions 17-24.* 825p. Source: OSTI; NTIS; INIS; GPO.

Recently it was found that, when a strong electric field is applied around a heated wire, two distinct film boiling heat transfer regimes are observed. In this paper, a semi-empirical model is derived to analyze the pool boiling process in the presence of non uniform electric field. The model takes into account the dielectrophoretic force acting on the bubbles as they grow and the effect of the electric field on the most dangerous wavelength. It is shown how the transition between the two film boiling regimes is possible for high strength electric fields. The threshold voltage for transition, transition heat fluxes and hysteresis values are compared with experimental outcomes showing a satisfactory agreement.

29515 (NUREG/CP–0142-Vol.4, pp. 3232-3244) **A simple delay model for two-phase flow dynamics.** Clausse, A. (Centro Atomico Bariloche (Argentina)); Delmastro, D.F.; Juanico', L.E. Nuclear Regulatory Commission, Washington, DC (United States). Div. of Systems Technology; American Nuclear Society, La Grange Park, IL (United States); American Inst. of Chemical Engineers, New York, NY (United States); American Society of Mechanical Engineers, New York, NY (United States); Canadian Nuclear Society, Toronto, ON (Canada); European Nuclear Society (ENS), Bern (Switzerland); Atomic Energy Society of Japan, Tokyo (Japan); Japan Society of Multiphase Flow, Kyoto (Japan). Sep 1995. (CONF-950904–Vol.4: 7. international meeting on nuclear reactor thermal hydraulics, Saratoga, NY (United States), 10-15 Sep 1995). In *Proceedings of the 7th International Meeting on Nuclear Reactor Thermal-Hydraulics NURETH-7. Sessions 17-24.* 825p. Source: OSTI; NTIS; INIS; GPO.

A model based in delay equations for density-wave oscillations is presented. High Froude numbers and moderate ones were considered. The equations were numerically analyzed and compared with more sophisticated models. The influence of the gravity term was

studied. Different kinds of behavior were found, particularly sub-critical and super-critical Hopf bifurcations. Moreover the present approach can be used to better understand the complicated dynamics of boiling flows systems.

29516 (NUREG/CR–4667) **Environmentally assisted cracking in light water reactors. Semiannual report, April 1994–September 1994, Volume 19.** Chopra, O.K. (and others); Chung, H.M.; Gavenda, D.J. Nuclear Regulatory Commission, Washington, DC (United States). Office of Nuclear Regulatory Research; Argonne National Lab., IL (United States). Sep 1995. 53p. Sponsored by Nuclear Regulatory Commission, Washington, DC (United States). DOE Contract W-31109-ENG-38. Source: OSTI; NTIS; INIS; GPO.

This report summarizes work performed by Argonne National Laboratory (ANL) on fatigue and environmentally assisted cracking (EAC) in light water reactors from April to September 1994. Topics that have been investigated include (a) fatigue of carbon and low-alloy steel used in piping and reactor pressure vessels, (b) EAC of austenitic stainless steels (SSs) and Alloy 600, and (c) irradiation-assisted stress corrosion cracking (IASCC) of Type 304 SS. Fatigue tests have been conducted on A106-Gr B and A533-Gr B steels in oxygenated water to determine whether a slow strain rate applied during different portions of a tensile-loading cycle are equally effective in decreasing fatigue life. Crack growth data were obtained on fracture-mechanics specimens of SSs and Alloy 600 to investigate EAC in simulated boiling water reactor (BWR) and pressurized water reactor environments at 289°C. The data were compared with predictions from crack growth correlations developed at ANL for SSs in water and from rates in air from Section XI of the ASME Code. Microchemical changes in high- and commercial-purity Type 304 SS specimens from control-blade absorber tubes and a control-blade sheath from operating BWRs were studied by Auger electron spectroscopy and scanning electron microscopy to determine whether trace impurity elements may contribute to IASCC of these materials.

29517 (NUREG/CR–6100) **Gate valve and motor-operator research findings.** Steele, R. Jr.; DeWall, K.G.; Watkins, J.C.; Russell, M.J.; Bramwell, D. Nuclear Regulatory Commission, Washington, DC (United States). Div. of Engineering Technology; Lockheed Idaho Technologies Co., Idaho Falls, ID (United States). Sep 1995. 100p. Sponsored by Nuclear Regulatory Commission, Washington, DC (United States). DOE Contract AC07-76ID01570. (INEL–94/0156). Source: OSTI; INIS; GPO; NTIS.

This report provides an update on the valve research being sponsored by the US Nuclear Regulatory Commission (NRC) and conducted at the Idaho National Engineering Laboratory (INEL). The research addresses the need to provide assurance that motor-operated valves can perform their intended safety function, usually to open or close against specified (design basis) flow and pressure loads. This report describes several important developments: Two methods for estimating or bounding the design basis stem factor (in rising-stem valves), using data from tests less severe than design basis tests; a new correlation for evaluating the opening responses of gate valves and for predicting opening requirements; an extrapolation method that uses the results of a best effort flow test to estimate the design basis closing requirements of a gate valve that exhibits atypical responses (peak force occurs before flow isolation); and the extension of the original INEL closing correlation to include low- flow and low-pressure loads. The report also includes a general approach, presented in step-by-step format, for determining operating margins for rising-stem valves (gate valves and globe valves) as well as quarter-turn valves (ball valves and butterfly valves).

29518 (PNL–8475) **Regulatory instrument review: Aging management of LWR cables, containment and basemat, reactor coolant pumps, and motor-operated valves.** Werry, E.V.; Somasundaram, S. Pacific Northwest Lab., Richland, WA (United States). Sep 1995. 227p. Sponsored by USDOE, Washington, DC (United States). DOE Contract AC06-76RL01830. Order Number DE96001152. Source: OSTI; NTIS; INIS; GPO Dep.

The results of Stage 2 of the Regulatory Instrument Review are presented in this volume. Selected regulatory instruments, such as the Code of Federal Regulations (CFR), US Nuclear Regulatory Commission (NRC), Regulatory Guides, and ASME Codes, were investigated to determine the extent to which these regulations apply aging management to selected safety-related components in nuclear power plants. The Regulatory Instrument Review was funded by the NRC under the Nuclear Plant Aging Research (NPAR) program. Stage 2 of the review focused on four safety-related structures and components; namely, cables, containment and basemat, reactor coolant pumps, and motor-operated valves. The review suggests that the primary-emphasis of the regulatory instruments was on the design, construction, start-up, and operation of a nuclear power plant, and that aging issues were primarily addressed after an aging-related problem was recognized. This Stage 2 review confirms the results of the prior review; (see Regulatory Instrument Review: Management of Aging of LWR Major Safety-Related Components NUREG/CR-5490. The observations indicate that the regulations generally address management of age-related degradation indirectly. Specific age-related degradation phenomena frequently are dealt with in bulletins and notices or through generic issues, letters, etc. The major recommendation of this report, therefore, is that the regulatory instruments should more directly and explicitly address the aging phenomenon and the management of the age-related degradation process.

2203 Fuel Elements

Refer also to citation(s) 28774

29519 (KRC–92N-J04) **Optimization of Burnable Poison Application Strategy.** Choi, W.P. (Korea Electric Power Corp. (KEPCO), Taejon (Korea, Republic of). Research Center); Lee, S.H.; Kim, J.K.; Ko, W.S.; Bae, S.M.; Kim, C.H.; Kim, S.H.; Lee, E.C.; Park, J.K.; Park, C.H.; Ji, S.K.; Chang, J.H.; Back, J.H.; Bang, J.G.; Song, J.W.; ChKorea Electric Power Corp. (KEPCO), Taejon (Korea, Republic of). Research Center. 1993. 269p. (In Korean). Order Number DE96703602. Source: OSTI; NTIS (US Sales Only).

This Study is Designed to derive the optimum strategy of burnable poison application through a comparative evaluation of two types of burnable absorbers that have been used for korean PWR plants; and integral type of variable enrichment Gd_2O_3/UO_2 and a discrete type of WABA (wet annular burnable absorber). Generally speaking, performance characteristics of burnable absorbers depends on the cycle length the poison concentration, number and position of poison rods in shimmed assembly, etc.. In order to make critical evaluation on two absorbers for optimum BP application policy, it is necessary to obtain the quantitative basis of comparison concerning design characteristics of the differently shimmed cores. The observations from numerical results are that the WABA is better in meeting design constraints on power peak and the MTC than the gadolinia but that gadolinia-shimmed core has longer cycle length and lower residual reactivity than WABA-shimmed core, and thereby the evelized fuel cycle cost of the gadolinia-shimmed core is 1-2% cheaper than the WABA-shimmed core. The mixed use of WABA and gadolinia is the most flexible in terms of man-hour spent for reload design efforts. Despite these observations, it is concluded that the gadolinia-shimmed core is comparable with the WABA-shimmed core in every aspect of design performances, since minor differences in design computations are within uncertainties if design methodology. It is also concluded that the mixed use of gadolinia and WABA is the best of the three options, from the standpoint of emergency design flexibility and probably the cycle length.

29520 (UTNL-R–0323) **Report of 6th new nuclear fuel research meeting, Yayoi Research Group. Recent topics on nuclear fuel technical development.** Tokyo Univ., Tokai, Ibaraki (Japan). Nuclear Engineering Research Lab. Mar 1995. 119p. (In Japanese). (CONF-9503190–: 6. new nuclear fuel research meeting, Yayoi Research Group, Tokyo (Japan), 17 Mar 1995). Order Number DE96701436. Source: OSTI; NTIS; INIS.

This issue is the collection of the papers presented at the title meeting. The 5 of the presented papers are indexed individually. (J.P.N.).

2204 Control Systems

Refer also to citation(s) 29588, 29776

29521 (BNL-NUREG–62207) **Validating cognitive support for operators of complex human-machine systems.** O'Hara, J. (Brookhaven National Lab., Upton, NY (United States)); Wachtel, J. Brookhaven National Lab., Upton, NY (United States). [1995]. 10p. Sponsored by Nuclear Regulatory Commission, Washington, DC (United States). DOE Contract AC02-76CH00016. (CONF-9508177–1: 5. European conference on cognitive science approaches to process control, Helsinki (Finland), 30 Aug - 1 sep 1995). Source: OSTI; NTIS; INIS; GPO.

Modern nuclear power plants (NPPs) are complex systems whose performance is the result of an intricate interaction of human and system control. A complex system may be defined as one which supports a dynamic process involving a large number of elements that interact in many different ways. Safety is addressed through defense-in-depth design and preplanning; i.e., designers consider the types of failures that are most likely to occur and those of high consequence, and design their solutions in advance. However, complex interactions and their failure modes cannot always be anticipated by the designer and may be unfamiliar to plant personnel. These situations may pose cognitive demands on plant personnel, both individually and as a crew. Other factors may contribute to the cognitive challenges of NPP operation as well, including hierarchal processes, dynamic pace, system redundancy and reliability, and conflicting objectives. These factors are discussed in this paper.

29522 (DOE/ER/75886–T2) **Drive reinforcement neurals networks for reactor control. Final report.** Williams, J.G.; Jouse, W.C. Arizona Univ., Tucson, AZ (United States). Engineering Experiment Station. 30 Jun 1995. 15p. Sponsored by USDOE, Washington, DC (United States). DOE Contract FG03-93ER75886 ; FG02-92ER75706. Order Number DE95017321. Source: OSTI; NTIS; INIS; GPO Dep.

This research focused on the development and characterization of drive reinforcement neural networks for reactor power control. Drive reinforcement networks are a novel class of neural networks that have been shown to be capable of learning relatively complex tasks, such as reactor startup demonstrated here. The networks also have the capability to function as a supervisor of lower level controllers. This document briefly discusses the task of nuclear reactor power control and elements of control necessary for various types of controllers to be integrated into a hierarchical control system. Next, the application of a drive reinforcement network to multi-stage control is presented.

29523 (INEL–95/00174) **Lessons learned from the introduction of cockpit automation in advanced technology aircraft.** Nelson, W.R.; Byers, J.C.; Haney, L.N.; Ostrom, L.T.; Reece, W.J. Lockheed Idaho Technologies Co., Idaho Falls, ID (United States). [1995]. 9p. Sponsored by National Aeronautics and Space Administration, Washington, DC (United States). DOE Contract AC07-94ID13223. (CONF-9506175–5: Computer-based human support systems: technology, methods and future, Philadelphia, PA (United States), 25-29 Jun 1995). Order Number DE96001624. Source: OSTI; NTIS; GPO Dep.

The commercial aviation industry has many years of experience in the application of computer based human support systems, for example the flight management systems installed in today's advanced technology ("glass cockpit") aircraft. This experience can be very helpful in the design and implementation of similar systems for nuclear power plants. The National Aeronautics and Space Administration (NASA) sponsored a study at the Idaho National Engineering Laboratory (INEL) to investigate pilot errors that occur during interaction with automated systems in advanced technology aircraft. In particular, we investigated the causes and potential corrective measures for pilot errors that resulted in altitude deviation incidents (i.e. failure to capture or maintain the altitude assigned by air traffic control). To do this, we analyzed altitude deviation events that have been reported in the Aviation Safety Reporting System (ASRS), NASA's data base of incidents self-reported by pilots and air traffic controllers. We developed models of the pilot tasks that are performed to capture and maintain altitude. Incidents from the ASRS data base were mapped onto the models, to highlight and categorize the potential causes of the errors. This paper reviews some of the problems that have resulted from the introduction of glass cockpit aircraft, the methodology used to analyze pilot errors, the lessons learned from the study of altitude deviation events, and the application of the results to the introduction of computer-based human support systems in nuclear power plants. In addition, a framework for using reliability engineering tools to incorporate lessons learned from operational experience into the design, construction, and operation of complex systems is briefly described.

29524 (INIS-mf–15119) **Application of analytical redundancy methods for early fault detection in nuclear power plant. Final report.** Seliger, R. Duisburg Univ. (Gesamthochschule) (Germany). Fachgebiet 8 - Mess-, Steuer- und Regelungstechnik. [1993]. 127p. (In German). Sponsored by Bundesministerium fuer Forschung und Technologie, Bonn (Germany). Foerderkennzeichen BMFT 1500715A. Order Number DE96706557. Source: OSTI; NTIS (US Sales Only); INIS.

The project activities proceeded along the following lines: Determination of the class of non-linear models to serve as a basis for the development of the residue generators. The models are to describe both the nominal and the faulty dynamic processes as precise and well-structured as possible. An aspect of particular importance was to explicitly simulate also modelling defects, such as parameter uncertainties, in order to be able to generate appropriate robustness against such effects. The class of models had to cover nonlinear space of states models for U-tube steam generators, as the algorithms developed were to be applied to this typical example of steam generators in nuclear power plant. Derivation and implementation of a mathematical model for a U-tube steam generator as required. This model was to serve as a basis for the residue generators. Verification of the mathematical decoupling conditions for the model. Implementation of a reference model on the digital computer. This reference model is not to be confused with the mathematical model for the design of the residue generators. The reference model is exclusively for the generation of test data, i.e. for generating transients and defects for testing the performance of the residue generators.

29525 (KRC–91C-J01) **Development of PWR Secondary Water Chemistry Monitoring and Diagnostic System for Nuclear Power Plants.** Kim, J.P. (Korea Electric Power Corp. (KEPCO), Taejon (Korea, Republic of). Research Center); Ku, B.M.; Park, J.K.; Hwang, J.R.; Kim, S.D.; Kim, N.Y.; Kim, C.T.; Seo, K.W.; Ko, J.Y.; Lee, H.S.; Kim, D.J.; Jeon, K.R.; Lee, B.J. Korea Electric Power Corp. (KEPCO), Taejon (Korea, Republic of). Research Center. 1993. 353p. (In Korean). Order Number DE96703578. Source: OSTI; NTIS (US Sales Only).

Water chemistry control of the PWR secondary systems has been recognized to be very crucial for extending the plant life and enhancing the equipment reliability. Thus, more and more attention has been given to the development of advanced computer-aided technology in other to improve such the short and long-term plant chemistry control practice. In this study, a PC-based PWR secondary water chemistry monitoring and diagnosis system has been developed. This system was designed to assist operators centralized supervision of overall plant chemistry, by early diagnosis of root-causes of any accident and by statistical processing and evaluation of a large volume of accumulated chemistry data. The demonstration system consists of three independent, distributed sub-system. Each sub-system with a dedicated 386-class personal computer has been installed at Secondary Chemistry Laboratory, KORI-3 and connected to the Chemistry Department Office via a dedicated telephone line for the bi-directional data and file communication. At present, this system is not a fully-developed version like a commercial product and may need continuous improvement. In the long run, further application of this system to other nuclear and fossil power plants will be pursued and a nation-wide plant chemistry data networking may be developed. (author). 29 refs. figs.

29526 (KRC–92N-J08) **A Study on the Automatic Transfer System of Auxiliary Power Supply for KORI Unit no.2.** Hong, S.R. (Korea Electric Power Corp. (KEPCO), Taejon (Korea, Republic of). Research Center); Ko, J.B.; Jeon, H.Y.; Choi, H.J.; Lee, B.J.; Yoon, J.W.; Kim, J.R.; Han, S.Y.; Choi, C.H. Korea Electric

Power Corp. (KEPCO), Taejon (Korea, Republic of). Research Center. 1993. 305p. (In Korean). Order Number DE96703600. Source: OSTI; NTIS (US Sales Only).

Nuclear power plant should be supplied with more than two independent off-site power as per 10CFR50 Appendix A GDC-17(GDC-17) and other regulations to enhance operational safety with the concept of preferred off-site power and alternative/ reserved off-site power. Power transfer schemes are generally classified with automatic fast transfer, automatic slow transfer, and manual transfer schemes. As each scheme has merits and demerits, two or three schemes including manual transfer scheme, are adapted. ANSI C50.41 recommends that the resultant vectorial voltage on power transfer between motor terminal voltage and incoming source voltage be no more than 1.33 pu V/Hz. So the power transfer scheme is designed by computer simulations or engineering practices to meet the recommendation. In our country foreign A/E companies designed the power transfer schemes by computer simulations for Kori no.2 Unit and Wolsung no.1 Unit, and by engineering practices for other nuclear units. The power transfer scheme of Kori no.2 Unit is designed with automatic fast transfer and manual transfer scheme by GEC of British A/E company. And the automatic fast transfer is restricted as per the computer simulation results when the nuclear reactor power is less than 10% of its rated power. So Korean Institute of Nuclear Safety made this point a issue to enhance the plant safety by shortening the power transfer times with automatic slow transfer scheme for the fault that may happen during plant startup. To fulfill the KINS's requirement on power transfer during plant startup and to enhance the operational safety and effectiveness, this study on the automatic power transfer is necessary. Also this study is necessary to develop the engineering technology of nuclear power plant and to enhance plant operational safety, availability and effectiveness in the future by establishing the simulation technique for the auxiliary power transfer. (author). 16 refs.

29527 (NUREG/CR–6159) **Using micro saint to predict performance in a nuclear power plant control room.** Lawless, M.T. (Micro Analysis and Design, Inc., Boulder, CO (United States)); Laughery, K.R.; Persenky, J.J. Nuclear Regulatory Commission, Washington, DC (United States). Office of Nuclear Regulatory Research; Micro Analysis and Design, Boulder, CO (United States). Sep 1995. 30p. Sponsored by Nuclear Regulatory Commission, Washington, DC (United States). Source: OSTI; NTIS; INIS; GPO.

The United States Nuclear Regulatory Commission (NRC) requires a technical basis for regulatory actions. In the area of human factors, one possible technical basis is human performance modeling technology including task network modeling. This study assessed the feasibility and validity of task network modeling to predict the performance of control room crews. Task network models were built that matched the experimental conditions of a study on computerized procedures that was conducted at North Carolina State University. The data from the "paper procedures" conditions were used to calibrate the task network models. Then, the models were manipulated to reflect expected changes when computerized procedures were used. These models' predictions were then compared to the experimental data from the "computerized conditions" of the North Carolina State University study. Analyses indicated that the models predicted some subsets of the data well, but not all. Implications for the use of task network modeling are discussed.

2205 Environmental Aspects

Refer also to citation(s) 29496, 29605, 30703, 30782, 30833, 30835

2206 Research, Test, Training, Production, Irradiation, Materials Testing Reactors

Refer also to citation(s) 28765, 28871, 28873, 28874, 28875, 28876, 28877, 28878, 28879, 28880, 28882, 28884, 28887, 28888, 28889, 29130, 29131, 29467, 29468, 29577, 29580, 29582, 29584, 29585, 29586, 29588, 29589, 29590, 29591, 29636, 29661, 29726, 29729, 29740, 29743, 29765, 29766, 29767, 29768, 29769, 29828, 30054, 30411, 30458, 30581

29528 (DOE/ER–0313/17, pp. 21-27) **Neutron flux spectra and radiation damage parameters for the Russian Bor-60 and SM-2 reactors.** Karasiov, A.V. (D.V. Efremov Scientific Rresearch Institute of Electrophysical Apparatus, St. Petersburg (Russian Federation)); Greenwood, L.R. Oak Ridge National Lab., TN (United States). Apr 1995. In *Fusion materials semiannual progress report for the period ending September 30, 1994.* 390p. Order Number DE95013663. Source: OSTI; NTIS; INIS; GPO Dep.

The objective is to compare neutron irradiation conditions in Russian reactors and similar US facilities. Neutron fluence and spectral information and calculated radiation damage parameters are presented for the BOR-60 (Fast Experimental Reactor - 60 MW) and SM-2 reactors in Russia. Their neutron exposure characteristics are comparable with those of the Experimental Breeder Reactor (ERB-II), the Fast Flux Test Facility (FFTF), and the High Flux Isotope Reactor (HFIR) in the United States.

29529 (DUN–504) **Neutron Beam Facility technical report.** Guthrie, G.D. Douglas United Nuclear, Inc., Richland, WA (United States). 29 Nov 1965. 7p. Sponsored by USDOE, Washington, DC (United States). DOE Contract AC06-76RL01830. Order Number DE95012714. Source: OSTI; NTIS; GPO Dep.

Using the high neutron fluxes of the Hanford reactors as a source, one can design a collimated neutron beam facility where fluxes of 10^6 to 10^7 (nv) are produced. The facility discussed in this report is designed to meet the following specifications: Sample exposures of 10^{10} (nvt) must be feasible; the beam must be at least 90% thermalized, and as gamma free as possible; maximum horizontal divergence should be no greater than 2°; and cross-section dimensions of the beam should be two by three inches.

29530 (INIS-mf–14561, pp. 19-23) **SAPHIR, how it ended.** Brogli, R. (Paul Scherrer Inst. (PSI), Villigen (Switzerland)); Hammer, J.; Wiezel, L.; Christen, R.; Heyck, H.; Lehmann, E. [1995]. 125p. In *Paul Scherrer Institut annual report 1994. Annex IV: PSI nuclear energy and safety research progress report 1994.* Order Number DE96601628.

On May 16th, 1994, PSI decided to discontinue its efforts to retrofit the SAPHIR reactor for operation at 10 MW. This decision was made because the effort and time for the retrofit work in progress had proven to be more complex than was anticipated. In view of the start-up of the new spallation-neutron source SINQ in 1996, the useful operating time between the eventual restart of SAPHIR and the start-up of SINQ became less than two years, which was regarded by PSI as too short a period to warrant the large retrofit effort. Following the decision of PSI not to re-use SAPHIR as a neutron source, several options for the further utilization of the facility were open. However, none of them appeared promising in comparison with other possibilities; it was therefore decided that SAPHIR should be decommissioned. A concerted effort was initiated to consolidate the nuclear and conventional safety for the post-operational period. (author) 3 figs., 3 tab.

29531 (INIS-mf–14593) **Degradation by radiation of the response of a thermocouple of a fuel element.** Rodriguez V, A. Universidad Nacional Autonoma de Mexico, Mexico City (Mexico). Facultad de Quimica. 1994. 66p. (In Spanish). Order Number DE96602732. Source: OSTI; NTIS (US Sales Only); INIS.

In the TRIGA Mark III Reactor of the National Institute of Nuclear Research, is necessary to use an instrumented fuel element for measurement the fuel temperature during pulses of power. This fuel element is exposed to daily temperature gradient of order to 390 Centigrade degrees in normal condition of reactor operation at 1 MW. The experience which this instrumented fuel elements is that useful life of the thermocouples is less then the fuel, because they show important changes in their chemistry composition and electrical specifications, until the point they don't give any response. So is necessary to know the factors that influenced in the shortening of the thermocouples life. The change in composition affects the thermocouple calibration depends on where the changes take place relative to the temperature gradient. The change will be dependent on the neutron flux and so the value of the neutron flux may be used as a measure or the composition change. If there is no neutron flux within the temperature gradient, there will be no composition change, and so the thermocouple calibration will no

change. If the neutron flux varies within the region in which a temperature gradients exists, the composition of the thermocouple will vary and the calibration will change. But the maximum change in calibration will occur if the neutron flux is high and constant within the region of the temperature gradient. In this case, a composition change takes place which is uniform throughout the gradient and so the emf output can be expected to change. In this reactor, the thermocouples are in the second case. Then, the relative position of the thermal and neutron flux gradients are the most important factor that explain the composition change after or 2,500 times of exposing the thermocouples to the temperature gradients of order to 390 Centigrade degrees. (Author).

29532 (JAERI–1332) **Design of high temperature Engineering Test Reactor (HTTR).** Saito, Shinzo (Japan Atomic Energy Research Inst., Oarai, Ibaraki (Japan). Oarai Research Establishment); Tanaka, Toshiyuki; Sudo, Yukio. Japan Atomic Energy Research Inst., Tokyo (Japan). Sep 1994. 268p. Order Number DE96701486. Source: OSTI; NTIS; INIS.

Construction of High Temperature Engineering Test Reactor (HTTR) is now underway to establish and upgrade basic technologies for HTGRs and to conduct innovative basic research at high temperatures. The HTTR is a graphite-moderated and helium gas-cooled reactor with 30 MW in thermal output and outlet coolant temperature of 850degC for rated operation and 950degC for high temperature test operation. It is planned to conduct various irradiation tests for fuels and materials, safety demonstration tests and nuclear heat application tests. JAERI received construction permit of HTTR reactor facility in February 1990 after 22 months of safety review. This report summarizes evaluation of nuclear and thermal-hydraulic characteristics, design outline of major systems and components, and also includes relating R and D result and safety evaluation. Criteria for judgment, selection of postulated events, major analytical conditions for anticipated operational occurrences and accidents, computer codes used in safety analysis and evaluation of each event are presented in the safety evaluation. (author).

29533 (JAERI-Conf–95-009, pp. 13-22) **Present status of HTTR construction and its testing program.** Tanaka, Toshiyuki (Japan Atomic Energy Research Inst., Oarai, Ibaraki (Japan). Oarai Research Establishment); Baba, Osamu; Shiozawa, Shusaku; Okubo, Minoru; Tobioka, Toshiaki. Japan Atomic Energy Research Inst., Tokyo (Japan). Mar 1995. (In Japanese). (CONF-9411223–: 3. JAERI seminar on HTGR technologies, Tokai (Japan), 7-8 Nov 1994). In *Proceedings of the third JAERI seminar on HTGR technologies.* 269p. Order Number DE95776544. Source: OSTI; NTIS; INIS.

It is essentially important for Japan with its limited energy resources to make efforts to enhance the diversity of energy supply and contribute the preservation of global environment by extended use of nuclear energy including high temperature heat for non-electric fields, e.g. hydrogen production. It is also expected that making basic researches at high temperature using HTGR will contribute to innovative basic research in future. Then, the construction of High Temperature engineering Test Reactor (HTTR), which is an HTGR with a maximum helium coolant temperature of 950degC at the reactor outlet, was decided by the Japanese Atomic Energy Commission in 1987 and is now under way by the JAERI. The construction of the HTTR started in March 1991, with first criticality in 1998 to be followed after commissioning testing. At present the HTTR reactor building and its containment vessel have been nearly completed and its main components, such as a reactor pressure vessel, an intermediate heat exchanger, hot gas pipings and core support structures, have been manufactured at their factories and delivered to the Oarai Research Establishment of the JAERI for their installation in the middle of 1994. Fuel fabrication will be started as well. The project is intended to establish and upgrade the technology basis necessary for HTGR developments. The IAEA Coordinated Research Programme on Design and Evaluation of Heat Utilization Systems for the HTTR was started in January 1994. Some heat utilization system is planned to be connected to the HTTR and demonstrated at the former stage of the second core. At present, steam-reforming of methane is the first candidate. The JAERI also plans to conduct material and fuel irradiation tests as an innovative basic research in 2000 after attaining rated power and coolant temperature in the HTTR. Preliminary tests on selected research subjects have been started at high temperature and under irradiation. (J.P.N.).

29534 (JAERI-Conf–95-009, pp. 25-39) **Manufacture of HTTR components. 1. Containment vessel, pressurized water cooler and co-axial double pipe.** Nomura, Shinichi (Mitsubishi Heavy Industries Ltd., Nagasaki (Japan). Nagasaki Shipyard and Machinery Works); Yamada, Masaya. Japan Atomic Energy Research Inst., Tokyo (Japan). Mar 1995. (In Japanese). (CONF-9411223–: 3. JAERI seminar on HTGR technologies, Tokai (Japan), 7-8 Nov 1994). In *Proceedings of the third JAERI seminar on HTGR technologies.* 269p. Order Number DE95776544. Source: OSTI; NTIS; INIS.

The high temperature gas cooled reactor is one of the potential candidates which can cope with global environmental problems and increasing energy demands in the future. With a view to establishing and improving technical foundations, HTTR is under construction to reach criticality in 1998. Mitsubishi Heavy Industries is undertaking manufacture of containment vessel, primary and secondary pressurized water coolers and primary and secondary co-axial double pipes for the main cooling system. The containment vessel is a cylindrical steel vessel with upper and lower ellipsoidal heads of seismic class A. Inner diameter of shell is about 18.5m, inner radius of upper and lower head is about 14m, total height is about 30m, and total weight is about 700 ton. In the development stage, we made elastic-plastic analysis of non-axisymmetric shapes and structural model test using 1/8 scale models to confirm the propriety of the structual design. The primary pressurized water cooler is a vertical U tube type heat exchanger of seismic class A with a thermal rating of 30MWt(20MWt at parallel operation). Shell side fluid is helium gas and tube side fluid is pressurized water. Main dimensions are about 2m in inner diameter of outer shell, about 7.6m in total height. Total weight is about 60 ton. In developing the cooler, we examined heat transfer performance using 1/2 scale models. The co-axial double pipe for the primary cooling system has a double construction with a thermal insulated inner pipe and a concentric outer pipe enclosing the inner pipe. Main dimensions are about 860mm in outer diameter of outer pipe and about 660mm in outer diameter of inner pipe, and total weight is about 20 ton. Assembly of the containment vessel was finished at the site in November 1992. Primary and secondary pressurized water coolers and primary and secondary co-axial double pipes were subjected to various tests and inspections by authorities concerned, completed in the shop in August 1994. (J.P.N.).

29535 (JAERI-Conf–95-009, pp. 43-58) **Manufacturing status of the HTTR core internal structures.** Miki, T. (Fuji Electric Co. Ltd., Kawasaki, Kanagawa (Japan)). Japan Atomic Energy Research Inst., Tokyo (Japan). Mar 1995. (In Japanese). (CONF-9411223–: 3. JAERI seminar on HTGR technologies, Tokai (Japan), 7-8 Nov 1994). In *Proceedings of the third JAERI seminar on HTGR technologies.* 269p. Order Number DE95776544. Source: OSTI; NTIS; INIS.

The core internal structures of the HTTR are essential components from viewpoint of safety function. They have the functions to support the core elements at the predetermined location and to maintain designed coolant flow distribution in the core. They also provide thermal and neutron shielding to the metallic core support structures and the RPV. The core internal structures consist of the graphite core support structures and the metallic core support structures. The graphite core support structures mainly consist of graphite blocks which are produced under strict quality control by applying ultrasonic testing, eddy current testing and 3-dimensional measurement. The graphite materials have stable mechanical characteristics up to high temperature in addition to good nuclear characteristics. The metallic core support structures support these graphite components and transmit the vertical and horizontal loads to the RPV. Austenite stainless or low alloy(Cr-Mo) steel, which has good heat resisting characteristics, are employed for these components. The detailed design of the HTTR core support structure was approved by the government through safety review, 1990-1991, and manufacturing was started in 1990. Machining of all graphite components, which consist of about 150 large blocks, was finished

in Sept. 1994 successfully. Machining and fabricating of the metallic components were also finished in Sept.. In order to confirm the function and performance of the core internal structures, prefabrication test is undergoing from Feb. 1994. After completion of the test, all components will be decomposed and the government inspection will be carried out. Then, the installation will be started at the HTTR site in spring of 1995. Also, the core elements are essential graphite components in the reactor and are now being produced and inspected in the factory. After the prefabrication test, they will be installed with the core internal structures. (J.P.N.).

29536 (JAERI-Conf–95-009, pp. 61-68) **Fabrication of He-He intermediate heat exchanger for HTTR.** Kisamori, Hiroyuki (Ishikawajima-Harima Heavy Industries Co. Ltd., Tokyo (Japan)). Japan Atomic Energy Research Inst., Tokyo (Japan). Mar 1995. (In Japanese). (CONF-9411223–: 3. JAERI seminar on HTGR technologies, Tokai (Japan), 7-8 Nov 1994). In *Proceedings of the third JAERI seminar on HTGR technologies.* 269p. Order Number DE95776544. Source: OSTI; NTIS; INIS.

The High Temperature Engineering Test Reactor (HTTR) being constructed by JAERI has a helium-helium intermediate heat exchanger (IHX) in a primary cooling system. As a member of the HTTR project, TOSHIBA/IHI has been responsible for the IHX. Our scope covers the design, fabrication, inspection and testing, installation, quality assurance, research and development. The IHX is a helium-helium heat exchanger with approximately 10 MW thermal rating operated at a very high temperature above 900degC. It transports the nuclear heat energy of primary helium gas to secondary helium gas and has to meet the requirement on structural integrity as class 1 component of the pressure boundary. The IHX is a vertical helically coiled counter flow type heat exchanger. And the tube bundle configuration is six layers of helical coils consisting of 96 tubes. Heat transfer tube material is Ni-base superalloy Hastelloy XR with high resistance for high temperature and corrosion in helium atomosphere. The shell diameter of the IHX is approximately 2.0m, total height is 10.0m and total weight is 65 ton. In order to fabricate the reliable IHX, research and development has been performed. Main items are as follows: (1) Making a reliable welded joint of Hastelloy XR and developing the reliable tube-to-tube automatic welder. (2) Making a precise helical coil to keep the tolerance of the tube bundle and assembling the six layers of the helical coil tube bundle precisely. To assure the integrity of the IHX for nuclear use, very severe inspections and testings such as radiographic test, ultrasonic test, creep rupture test, pneumatic test, helium leak test are required. Fabrication of the IHX was successfully completed in September 1994, and the IHX is now under installation in the containment vessel in the reactor building. (author).

29537 (JAERI-Conf–95-009, pp. 71-81) **Manufacturing of HTTR pressure vessel.** Shiozawa, Shusaku (Japan Atomic Energy Research Inst., Oarai, Ibaraki (Japan). Oarai Research Establishment); Fukaya, Yoshio; Asami, Takao; Yamaguchi, Shigeru. Japan Atomic Energy Research Inst., Tokyo (Japan). Mar 1995. (In Japanese). (CONF-9411223–: 3. JAERI seminar on HTGR technologies, Tokai (Japan), 7-8 Nov 1994). In *Proceedings of the third JAERI seminar on HTGR technologies.* 269p. Order Number DE95776544. Source: OSTI; NTIS; INIS.

High Temperature Engineering Test Reactor (HTTR) is being constructed by the Japan Atomic Energy Research Institute to establish and upgrade the technology basis for HTGR, serving at the same time as a potential tool for new and innovative basic research. Reactor Pressure Vessel (RPV) of HTTR is self-standing with skirt and vertical cylindrical vessel, and its major dimensions are 5.5 m inside diameter and 13.2 m inside height. Design pressure and temperature are 4.7 MPa and 440degC, respectively. Therefore, for the RPV material, 2·1/4Cr-1Mo(NT) steel was chosen because it has superior strength against creep. RPV has some structural characteristics. For example, the thermal shield is installed on the inner surface of the top head to prevent the high temperature exposure in the accident. And the omega-shaped seal is welded between the head flange and the shell flange to prevent the coolant leakage. Narrow gap MIG welding which was developed by Babcock Hitachi, is adopted for major welded joints. Narrow gap MIG welding with low heat input can improve fracture toughness of welded joints. And large size forging is used as the top head, because ISI is required at the welded joint of the stand-pipe nozzle and the top head. This forging was developed by the steel maker in co-operation with Babcock Hitachi. RPV was started to fabricate in 1992 October, and was completed in this August. It was transported from the works to Oarai Port by sea, and to the construction site by land, then installed in the reactor building. (author).

29538 (JAERI-Conf–95-009, pp. 225-238) **Design of a heat utilization system to be connected to the HTTR.** Hada, Kazuhiko (Japan Atomic Energy Research Inst., Oarai, Ibaraki (Japan). Oarai Research Establishment); Fujimoto, Nozomu; Shibata, Taiju; Shiozawa, Shusaku. Japan Atomic Energy Research Inst., Tokyo (Japan). Mar 1995. (In Japanese). (CONF-9411223–: 3. JAERI seminar on HTGR technologies, Tokai (Japan), 7-8 Nov 1994). In *Proceedings of the third JAERI seminar on HTGR technologies.* 269p. Order Number DE95776544. Source: OSTI; NTIS; INIS.

Top priority objective of development of the first heat utilization system to be connected to the HTTR is the demonstration of technical feasibility of a nuclear process heat utilization system for the first time in the world. Key features of a nuclear process heat utilization system significantly differing from a conventional fossil-fired process heat utilization system are (1) the heat source of nuclear reactor, (2) heat transferring fluid of pressurized helium and (3) a closed system helium circuit. Major issues to be demonstrated at the HTTR heat utilization system are, therefore, (1) the safety as the nuclear reactor system, (2) helium-heated components and (3) a control system for the closed circuit including start-up and shutdown control system. A steam reforming system was selected as a primary candidate for design of the first HTTR heat utilization system due to the following reasons: - Basic system arrangement and heat of endothermic chemical reactions occurred in steam reformer are similar. - A helium-heated steam reformer has been basically developed. Successful operation of the HTTR steam reforming system will demonstrate the feasibility of control and safety design concepts that are applicable to major nuclear process heat chemical systems. Major design achievements up to now are as follows: (1) Its main system arrangement has been optimized to effectively utilize the nuclear heat. (2) Proposed design concepts of steam reformer will improve the heat utilization efficiency to approximately 80%, comparable to a conventional fossil-fired reformer. (3) Any procedure for start-up and shutdown of steam reforming system has been found to be applicable due to a large heat sink capacity of steam generator installed downstream of steam reformer. (author).

29539 (JAERI-Review–95-010) **Basic experiments of reactor physics using the research reactor JRR-4 and NSRR.** Obara, Toru (Tokyo Inst. of Tech. (Japan). Research Lab. for Nuclear Reactors); Horiki, Oichiro; Nakajima, Teruo; Watanabe, Shukichi; Ishijima, Kiyomi; Katanishi, Shoji. Japan Atomic Energy Research Inst., Tokyo (Japan). Jun 1995. 44p. (In Japanese). Order Number DE96701319. Source: OSTI; NTIS; INIS.

This report is based on lectures given to graduate students of Tokyo Institute of Technology. It covers educational experiments conducted with the Japan Research Reactor 4 (JRR-4) and the Nuclear Safety Research Reactor (NSRR) at Japan Atomic Energy Research Institute in August 1994. During this period, the following basic experiments on reactor physics were performed: JRR-4; (1) Control rod calibration by positive period method, (2) Measurement of Xe poisoning after high power operation, and NSRR; Measurement of reactor kinetics during power excursion caused by prompt critical. The principle of experiments, experimental procedure, and analysis of results are described in this report. (author).

29540 (LA-UR–95-17922, pp. 137-147) **The results of the investigations of Russian Research Center - "Kurchatov Institute" on molten salt applications to problems of nuclear energy systems.** Novikov, V.M. (Russian Research Center, Moscow (Russian Federation)). Los Alamos National Lab., NM (United States). [1995]. (CONF-9407103–: International conference on accelerator-driven transmutation technologies and applications, Las Vegas, NV (United States), 25 Jul - 1 aug 1994). In *AIP conference on accelerator driven transmutation technologies and applications, Los Vegas, Nevada, July 25-29, 1994.* 958p. Order Number DE95014018. Source: OSTI; NTIS; INIS.

The results of investigations on molten salt (MS) applications to problems of nuclear energy systems that have been conducted in Russian Research "Kurchatov Institute" are presented and discussed. The spectrum of these investigations is rather broad and covers the following items: physical characteristics of molten salt nuclear energy systems (MSNES); nuclear and radiation safety of MSNES; construction materials compatible with MS of different compositions; technological aspects of MS loops; in-reactor loop testing. It is shown that main findings of completed program support the conclusion that there are no physical nor technological obstacles on way of MS application to different nuclear energy systems.

29541 (LA-UR–95-17922, pp. 147-149) **An active target for the accelerator-based transmutation system.** Grebyonkin, K.F. (Institute of Technical Physics, Chelyabinsk (Russian Federation)). Los Alamos National Lab., NM (United States). [1995]. (CONF-9407103–: International conference on accelerator-driven transmutation technologies and applications, Las Vegas, NV (United States), 25 Jul - 1 aug 1994). In *AIP conference on accelerator driven transmutation technologies and applications, Los Vegas, Nevada, July 25-29, 1994.* 958p. Order Number DE95014018. Source: OSTI; NTIS; INIS.

Consideration is given to the possibility of radical reduction in power requirements to the proton accelerator of the electronuclear reactor due to neutron multiplication both in the blanket and the target of an active material. The target is supposed to have the fast-neutron spectrum, and the blanket-the thermal one. The blanket and the target are separated by the thermal neutrons absorber, which is responsible for the neutron decoupling of the active target and blanket. Also made are preliminary estimations which illustrate that the realization of the idea under consideration can lead to significant reduction in power requirements to the proton beam and, hence considerably improve economic characteristics of the electronuclear reactor.

29542 (LA-UR–95-17922, pp. 424-430) **ITEP Subcritical Neutron Generator driven by charged particle accelerator.** Shvedov, O.V. (Institute of Theoretical and Experimental Physics, Moscow (Russian Federation)); Chuvilo, I.V.; Vasiliev, V.V. Los Alamos National Lab., NM (United States). [1995]. (CONF-9407103–: International conference on accelerator-driven transmutation technologies and applications, Las Vegas, NV (United States), 25 Jul - 1 aug 1994). In *AIP conference on accelerator driven transmutation technologies and applications, Los Vegas, Nevada, July 25-29, 1994.* 958p. Order Number DE95014018. Source: OSTI; NTIS; INIS.

A research facility prototype including a combination of a linear accelerator, a neutron generating target, a nuclear safety ensuring and means of its attainment for Subcritical Neutron Generator are considered. The scheme of the multiplying is shown. The assembly will be mounted in the body of the partly dismantled ITEP HWR. Requirements for subcritical assembly are worked out and their feasibility within the framework of the heavy-water blanket is shown. The facility's application as a full-scale model of more powerful installations of this kind and for fundamental experimental research has been investigated.

29543 (LA-UR–95-17922, pp. 525) **The concept of electronuclear facility for useful power generation and minor actinides transmutation.** Bergelson, B.R. (ITEP, Moscow (Russian Federation)); Balyuk, S.A. Los Alamos National Lab., NM (United States). [1995]. (CONF-9407103–: International conference on accelerator-driven transmutation technologies and applications, Las Vegas, NV (United States), 25 Jul - 1 aug 1994). In *AIP conference on accelerator driven transmutation technologies and applications, Los Vegas, Nevada, July 25-29, 1994.* 958p. Order Number DE95014018. Source: OSTI; NTIS; INIS.

The possibility is shown to design in principle the double-purpose liquid fuel electro nuclear facility for useful power generation and minor actinides transmutation in U-Pu fuel cycle conditions. D_2O and a melt of fluorine salts are considered as a working media for liquid fuel. Such facility replenished with depicted or natural uranium only makes it possible to generate power of 900 MW (c) for external consumers and serve 20 WWER-1000 reactors for transmutation of MA. The facility could be thought as an alternative to fast reactors since appr. 30% of the total power confined in uranium is utilized in it.

29544 (LA-UR–95-17922, pp. 526-533) **Conception of electron beam-driven subcritical molten salt ultimate safety reactor.** Abalin, S.S. (Kurchatov Institute, Moscow (Russian Federation)); Alekseev, P.N.; Ignat'ev, V.V. Los Alamos National Lab., NM (United States). [1995]. (CONF-9407103–: International conference on accelerator-driven transmutation technologies and applications, Las Vegas, NV (United States), 25 Jul - 1 aug 1994). In *AIP conference on accelerator driven transmutation technologies and applications, Los Vegas, Nevada, July 25-29, 1994.* 958p. Order Number DE95014018. Source: OSTI; NTIS; INIS.

This paper is a preliminary sketch of a conception to develop the "ultimate safety reactor" using modern reactor and accelerator technologies. This approach would not require a long-range R&D program. The ultimate safety reactor could produce heat and electric energy, expand the production of fuel, or be used for the transmutation of long-lived wastes. The use of the combined double molten salt reactor system allows adequate neutron multiplication to permit using an electron accelerator for the initial neutron flux. The general parameters of such a system are discussed in this paper.

29545 (LA-UR–95-17922, pp. 541-547) **Design considerations and evaluations of an accelerator-driven fluid fuel transmuter.** Lizana, P. (Institute for Safety Research and Reactor Technology, Juelich (Germany)); Lypsch, F.; Phlippen, P.W. Los Alamos National Lab., NM (United States). [1995]. (CONF-9407103–: International conference on accelerator-driven transmutation technologies and applications, Las Vegas, NV (United States), 25 Jul - 1 aug 1994). In *AIP conference on accelerator driven transmutation technologies and applications, Los Vegas, Nevada, July 25-29, 1994.* 958p. Order Number DE95014018. Source: OSTI; NTIS; INIS.

A fluid fuel transmuter is proposed on the basis of circulating lead forming the fluid carrier material for long-lived actinides. Thermalization of neutrons is achieved by the use of graphite in the blanket leading to low actinide concentrations, typically around 100 g/l. An eigenvalue of 0.95 is aimed at and the extraneous source neutrons are provided by the interaction of 1.6 GeV protons with a central lead target (spallation process). Fuel depletion and neutron transport calculations are discussed with a view to the technical feasibility and possible advantageous design modifications.

29546 (LA-UR–95-17922, pp. 548-555) **An acclerator-based installation of small power with the lead-bismuth coolant.** Gorshkov, V.T. (Research and Development Bereau, Podolsk (Russian Federation)); Yefimov, E.I.; Novikova, N.N. Los Alamos National Lab., NM (United States). [1995]. (CONF-9407103–: International conference on accelerator-driven transmutation technologies and applications, Las Vegas, NV (United States), 25 Jul - 1 aug 1994). In *AIP conference on accelerator driven transmutation technologies and applications, Los Vegas, Nevada, July 25-29, 1994.* 958p. Order Number DE95014018. Source: OSTI; NTIS; INIS.

The structure of the accelerator-based installation is described that includes the subcritical reactor-blanket with power 15 MW(h) cooled with lead-bismuth, the lead-bismuth flow target where a beam of α-particle is injected, the equipment of a primary and secondary curcuits. Some results of calculations and estimations are discussed that have been carried out to justify the target and blanket constructions. Some main characteristics of the installation are presented.

29547 (LA-UR–95-17922, pp. 551-587) **A proton-driven, intense, subcritical, fission neutron source for radioisotope production.** Jongen, Y. (Chemin du Cyclotron, Louvain-la-Neuve (Belgium)). Los Alamos National Lab., NM (United States). [1995]. (CONF-9407103–: International conference on accelerator-driven transmutation technologies and applications, Las Vegas, NV (United States), 25 Jul - 1 aug 1994). In *AIP conference on accelerator driven transmutation technologies and applications, Los Vegas, Nevada, July 25-29, 1994.* 958p. Order Number DE95014018. Source: OSTI; NTIS; INIS.

^{99m}Tc, the most frequently used radioisotope in nuclear medicine, is distributed as $^{99}Mo => ^{99m}Tc$ generators. ^{99}Mo is a fission product of ^{235}U. To replace the aging nuclear reactors used

today for this production, the author proposes to use a spallation neutron source, with neutron multiplication by fission. A 150 MeV, H^- cyclotron can produce a 225 kW proton beam with 50% total system energy efficiency. The proton beam would hit a molten lead target, surrounded by a water moderator and a graphite reflector, producing around 0.96 primary neutron per proton. The primary spallation neutrons, moderated, would strike secondary targets containing a subcritical amount of ^{235}U. The assembly would show a k_{eff} of 0.8, yielding a fivefold neutron multiplication. The thermal neutron flux at the targets location would be 2×10^{14} n/cm^2.s, resulting in a fission power of 500 to 750 kW. One such system could supply the world demand in ^{99}Mo, as well as other radioisotopes. Preliminary indications show that the cost would be lower than the cost of a commercial 10 MW isotope production reactor. The cost of operation, of disposal of radiowaste and of decommissioning should be significantly lower as well. Finally, the non-critical nature of the system would make it more acceptable for the public than a nuclear reactor and should simplify the licensing process.

29548 (LA-UR–95-17922, pp. 568-573) **"Transmutation efficiency calculation in the blanket on melted salts with central neptunium target".** Kolesov, V.F. (Russia Federal Nuclear Center, Arzamas (Russian Federation)); Shtarev, S.K.; Khoruzhiy, V.K. Los Alamos National Lab., NM (United States). [1995]. (CONF-9407103–: International conference on accelerator-driven transmutation technologies and applications, Las Vegas, NV (United States), 25 Jul - 1 aug 1994). In *AIP conference on accelerator driven transmutation technologies and applications, Los Vegas, Nevada, July 25-29, 1994.* 958p. Order Number DE95014018. Source: OSTI; NTIS; INIS.

In the limits of ABC project version of two-sectional reactor system in the form of combination of subcritical blanket on melted salts and multiplying target from threshold fissile material ^{237}Np is considered. This research is the development of the VNIIEF's earlier work's (Russia) investigating of usage possibilities in ABC project the conception of multisectional blankets with single-sided neutron coupling between sections. With the help of Monte-Carlo program the calculations results of system mentioned are given. The possibility of accelerator's considerable power reduction at the account of thorium target substitution with neptunium-237 multiplying target is shown.

29549 (LA-UR–95-17922, pp. 603-609) **A beamline systems model for Accelerator-Driven Transmutation Technology (ADTT) facilities.** Todd, A.M.M. (Grumman Research and Development Center, Princeton, NJ (United States)); Paulson, C.C.; Peacock, M.A. Los Alamos National Lab., NM (United States). [1995]. (CONF-9407103–: International conference on accelerator-driven transmutation technologies and applications, Las Vegas, NV (United States), 25 Jul - 1 aug 1994). In *AIP conference on accelerator driven transmutation technologies and applications, Los Vegas, Nevada, July 25-29, 1994.* 958p. Order Number DE95014018. Source: OSTI; NTIS; INIS.

A beamline systems code, that is being developed for Accelerator-Driven Transmutation Technology (ADTT) facility trade studies, is described. The overall program is a joint Grumman, G.H. Gillespie Associates (GHGA) and Los Alamos National Laboratory effort. The GHGA Accelerator Systems Model (ASM) has been adopted as the framework on which this effort is based. Relevant accelerator and beam transport models from earlier Grumman systems codes are being adapted to this framework. Preliminary physics and engineering models for each ADTT beamline component have been constructed. Examples noted include a Bridge Coupled Drift Tube Linac (BCDTL) and the accelerator thermal system. A decision has been made to confine the ASM framework principally to beamline modeling, while detailed target/blanket, balance-of-plant and facility costing analysis will be performed externally. An interfacing external balance-of-plant and facility costing model, which will permit the performance of iterative facility trade studies, is under separate development. An ABC (Accelerator Based Conversion) example is used to highlight the present models and capabilities.

29550 (LA-UR–95-17922, pp. 737-743) **Accelerator-based transmuter-breeder and energy producer from transuranic actinides and thorium.** Batskikh, G.I. (Moscow Radiotechnical Institute (Russian Federation)); Fedotov, A.P.; Murin, B.P. Los Alamos National Lab., NM (United States). [1995]. (CONF-9407103–: International conference on accelerator-driven transmutation technologies and applications, Las Vegas, NV (United States), 25 Jul - 1 aug 1994). In *AIP conference on accelerator driven transmutation technologies and applications, Los Vegas, Nevada, July 25-29, 1994.* 958p. Order Number DE95014018. Source: OSTI; NTIS; INIS.

A concept of an accelerator-driven subcritical blanket with Pb or molten salt (heavy chloride) as the primary target, a graphite moderator-reflector to produce high-density thermal neutron fluxes and a fluid fuel carrying TUA actinides and Th-U, is being studied at MRTI. A driver is CW H^+/H^- linac: 1 GeV, 200 mA, SIU-DTL-D&W structure energized by regotron as RF power supply.

29551 (LA-UR–95-17922, pp. 744-750) **Plutonium (TRU) transmutation and ^{233}U production by single-fluid type accelerator molten-salt breeder (AMSB).** Furukaw, Kazuo (Tokai Univ., Kanagawa (Japan)); Kato, Yoshio; Chigrinov, Sergey E. Los Alamos National Lab., NM (United States). [1995]. (CONF-9407103–: International conference on accelerator-driven transmutation technologies and applications, Las Vegas, NV (United States), 25 Jul - 1 aug 1994). In *AIP conference on accelerator driven transmutation technologies and applications, Los Vegas, Nevada, July 25-29, 1994.* 958p. Order Number DE95014018. Source: OSTI; NTIS; INIS.

For practical/industrial disposition of Pu(TRU) by accelerator facility, not only physical soundness and safety but also the following technological rationality should be required: (1) few R&D items including radiation damage, heat removal and material compatibility; (2) few operation/maintenance/processing works: (3) few reproduction of radioactivity; (4) effective energy production in parallel. This will be achieved by the new modification of Th-fertilizing Single-Fluid type Accelerator Molten-Salt Breeder (AMSB), by which a global nuclear energy strategy for next century might be prepared.

29552 (LA-UR–95-17922, pp. 751-761) **Actinide and Xenon reactivity effects in ATW high flux systems.** Woosley, M. (Univ. of Virginia, Charlottesville, VA (United States)); Olson, K.; Henderson, D.L. Los Alamos National Lab., NM (United States). [1995]. (CONF-9407103–: International conference on accelerator-driven transmutation technologies and applications, Las Vegas, NV (United States), 25 Jul - 1 aug 1994). In *AIP conference on accelerator driven transmutation technologies and applications, Los Vegas, Nevada, July 25-29, 1994.* 958p. Order Number DE95014018. Source: OSTI; NTIS; INIS.

In this paper, initial system reactivity response to flux changes caused by the actinides and xenon are investigated separately for a high flux ATW system. The maximum change in reactivity after a flux change due to the effect of the changing quantities of actinides is generally at least two orders of magnitude smaller than either the positive or negative reactivity effect associated with xenon after a shutdown or start-up. In any transient flux event, the reactivity response of the system to xenon will generally occlude the response due to the actinides.

29553 (LA-UR–95-17922, pp. 762-768) **Transmutation and inventory analysis in an ATW molten salt system.** Sisolak, J.E. (Univ. of Wisconsin, Madison, WI (United States)); Truebenbach, M.T.; Henderson, D.L. Los Alamos National Lab., NM (United States). [1995]. (CONF-9407103–: International conference on accelerator-driven transmutation technologies and applications, Las Vegas, NV (United States), 25 Jul - 1 aug 1994). In *AIP conference on accelerator driven transmutation technologies and applications, Los Vegas, Nevada, July 25-29, 1994.* 958p. Order Number DE95014018. Source: OSTI; NTIS; INIS.

As an extension of earlier work to determine the equilibrium state of an ATW molten salt, power producing, reactor/transmuter, the WAIT code provides a time dependent view of material inventories and reactor parameters. By considering several cases, the authors infer that devices of this type do not reach equilibrium for dozens of years, and that equilibrium design calculations are inapplicable over most of the reactor life. Fissile inventory and k_{eff} both vary by factors of 1.5 or more between reactor startup and ultimate convergence to equilibrium.

29554 (LA-UR–95-17922, pp. 769-775) **The concept of the double-purpose electro-nuclear facility.** Bergelson, B.P. (Institute of theoretical and experimental physics, Moscow (Russian Federation)); Balyuk, S.A. Los Alamos National Lab., NM (United States). [1995]. (CONF-9407103–: International conference on accelerator-driven transmutation technologies and applications, Las Vegas, NV (United States), 25 Jul - 1 aug 1994). In *AIP conference on accelerator driven transmutation technologies and applications, Los Vegas, Nevada, July 25-29, 1994.* 958p. Order Number DE95014018. Source: OSTI; NTIS; INIS.

The parameters have been determined on a conceptual level of the electro-nuclear facility intended for electric power generation and minor actinide transmutation. Electro-nuclear facilities (ENFs) have been developed without apparent success for many years. The main difficulties are associated with high accelerator cost and absence of their own clearly defined place for ENFs in the nuclear-power complex. In recent years, however, the situation has changed in many aspects in connection with the rise in safety requirements for nuclear power industry and because of the necessity to decrease the equilibrium level of the long-lived radiotoxicity in particular. In the authors opinion double-purpose ENFs designed for power generation and tansmutation of minor actinides are promising. The results of conceptual investigations for such a facility being operated on liquid fuel in the condition of a uranium-plutonium fuel cycle are given here

29555 (LA-UR–95-17922, pp. 776-782) **The influence of external source intensity in accelerator/target/blanket system on conversion ratio and fuel cycle.** Kochurov, B.P. (Institute for Theoretical and Experimental Physics, Moscow (Russian Federation)). Los Alamos National Lab., NM (United States). [1995]. (CONF-9407103–: International conference on accelerator-driven transmutation technologies and applications, Las Vegas, NV (United States), 25 Jul - 1 aug 1994). In *AIP conference on accelerator driven transmutation technologies and applications, Los Vegas, Nevada, July 25-29, 1994.* 958p. Order Number DE95014018. Source: OSTI; NTIS; INIS.

The analysis of neutron balance relation for a subcritical system with external source shows that a high ratio of neutron utilization (conversion ratio, breeding ratio) much exceeding similar values for nuclear reactors (both thermal or fast spectrum) is reachable in accelerator/target/blanket system with high external neutron source intensity. An accelerator/target/blanket systems with thermal power in blanket about 1850 Mwt and operating during 30 years have been investigated. Continual feed up by plutonium (fissile material) and Tc-99 (transmuted material) was assumed. Accelerator beam intensity differed 6.3 times (16 mA - Case 1, and 100 mA-Case 2). Conversion ratio (CR) was defined as the ratio of Tc-99 nuclei transmuted to the number of Pu nuclei consumed. High value of conversion ratio considerably exceeding 1 (CR=1.66) was obtained in the system with high source intensity as compared with low source system (CR=0.77). Net output of electric power of high source intensity system is about twice lower due to consumption of electric power for accelerator feed up. The loss of energy for Tc-99 transmutation is estimated as 40 Mev(el)/nuclei. Yet high conversion ratio (or breeding ratio) achievable in electronuclear installations with high intensity of external source can effectively be used to close fuel cycle (including incineration of wastes) or to develop growing nuclear power production system.

29556 (LA-UR–95-17922, pp. 784) **The chemistry of ABC.** Jensen, R.J. (Los Alamos National Laboratory, NM (United States)). Los Alamos National Lab., NM (United States). [1995]. (CONF-9407103–: International conference on accelerator-driven transmutation technologies and applications, Las Vegas, NV (United States), 25 Jul - 1 aug 1994). In *AIP conference on accelerator driven transmutation technologies and applications, Los Vegas, Nevada, July 25-29, 1994.* 958p. Order Number DE95014018. Source: OSTI; NTIS; INIS.

ABC stand for accelerator based conversion of Pu. It is a unique approach to Pu destruction that allows for a well controlled and complete burn of Pu as may be required by treaty or policy. The central idea of the approach is to provide a spallation source of neutrons that allows the operation of a fissioning system without a critical mass and at a K effective less than one. Material to be fissioned is suspended in a molten salt medium for high temperature control and on-line removal of neutron absorbing fission products. This paper discusses the issues associated with the selection and operation of a molten salt chemical system: redox control, product removal, material feed, solubilities, deposition control, and a host of operational procedures.

29557 (LA-UR–95-17922, pp. 785-790) **Actinide removal from molten salts by chemical oxidation and salt distillation.** McNeese, J.A. (Los Alamos National Laboratory, NM (United States)); Garcia, E.; Dole. V.R. Los Alamos National Lab., NM (United States). [1995]. (CONF-9407103–: International conference on accelerator-driven transmutation technologies and applications, Las Vegas, NV (United States), 25 Jul - 1 aug 1994). In *AIP conference on accelerator driven transmutation technologies and applications, Los Vegas, Nevada, July 25-29, 1994.* 958p. Order Number DE95014018. Source: OSTI; NTIS; INIS.

Actinide removal from molten salts can be accomplished by a two step process where the actinide is first oxidized to the oxide using a chemical oxidant such as calcium carbonate or sodium carbonate. After the actinide is precipitated as an oxide the molten salt is distilled away from the actinide oxides leaving a oxide powder heel and an actinide free distilled salt that can be recycled back into the processing stream. This paper discusses the chemistry of the oxidation process and the physical conditions required to accomplish a salt distillation. Possible application of an analogous process sequence for a proposed accelerator driven transmutation molten salt process is also discussed.

29558 (LA-UR–95-17922, pp. 791-797) **The possibility of fuel cycle design for ABC/ATW complex with molten fuel on LiF-BeF_2 basis.** Naumov, V.S. (Research Institute of Atomic Reactors, Dimitrovgrad (Russian Federation)); Bychkov, A.V. Los Alamos National Lab., NM (United States). [1995]. Contract 5058L0013-9Y. (CONF-9407103–: International conference on accelerator-driven transmutation technologies and applications, Las Vegas, NV (United States), 25 Jul - 1 aug 1994). In *AIP conference on accelerator driven transmutation technologies and applications, Los Vegas, Nevada, July 25-29, 1994.* 958p. Order Number DE95014018. Source: OSTI; NTIS; INIS.

The experience gained in the field of the development of molten salt reactors (MSR) can be made a basis of chemical processing of the ABC/ATW liquid fuel. The following combination of two processing principles are proposed for the ABC/ATW fuel (LiF-BeF_2-$PuF_{3,(4)}$ - MAF_n): - continious removal of radioactive gases, volatile impurities and "noble fission products"; - portion-by-portion electrochemical processing with removal of rare earth elements and some other fission products at an autonomous plant. After processing the fuel salt is brought back to the blanket of the ABC/ATW complex. The analysis of information previously published in different countries allows for a safe assumption that the ABC/ATW fuel cycle with liquid fuel salt is feasible and can be demonstrated experimentally.

29559 (LA-UR–95-17922, pp. 798-823) **Centrifugal separation for miscible solutions: Fundamentals and applications to separation of molten salt nuclear material.** Ning Li (Los Alamos National Laboratory, NM (United States)); Camassa, R.; Ecke, R.E. Los Alamos National Lab., NM (United States). [1995]. (CONF-9407103–: International conference on accelerator-driven transmutation technologies and applications, Las Vegas, NV (United States), 25 Jul - 1 aug 1994). In *AIP conference on accelerator driven transmutation technologies and applications, Los Vegas, Nevada, July 25-29, 1994.* 958p. Order Number DE95014018. Source: OSTI; NTIS; INIS.

The authors report on the physical separation of dilute solutions using centrifugal techniques. They use numerical simulations of the diffusion and sedimentation dynamics of centrifugation to model the approach to an equilibrium concentration profile. They verify experimentally the equilibrium profiles for aqueous solutions of different salts under rotation at 25000 rpm corresponding to centrifugal accelerations of about 57,000 g and 75,000 g in two different commercial centrifuges. These measurements provide ratios of sedimentation and diffusion coefficients. The authors show experimental results for the dynamics of separation that confirm the

predictions of the theoretical model. They also measure the mass diffusion coefficient for several solutions. Although the relaxation to equilibrium is long, they have determined a method for efficiently extracting enriched components from a ternary mixture based on fast dynamics at early times. These dynamics are modeled in numerical simulations with realistic fluid parameters. Based on these studies the authors show that a multistage centrifugal separation process could provide efficient physical separation of actinides and fission products from a molten-salt solution in proposed transmutation/energy-production systems. The authors consider technical issues in the design of such a separation system.

29560 (LA-UR–95-17922, pp. 824) **Convective instabilities in liquid centrifugation for nuclear wastes separation.** Camassa, R. (Los Alamos National Laboratory, NM (United States)). Los Alamos National Lab., NM (United States). [1995]. (CONF-9407103–: International conference on accelerator-driven transmutation technologies and applications, Las Vegas, NV (United States), 25 Jul - 1 aug 1994). In *AIP conference on accelerator driven transmutation technologies and applications, Los Vegas, Nevada, July 25-29, 1994.* 958p. Order Number DE95014018. Source: OSTI; NTIS; INIS.

The separation of fission products from liquid solutions using centrifugal forces may prove an effective alternative to chemical processing in cases where radioactive materials necessitate minimal mixed-waste products or when allowing access to sophisticated chemical processing is undesirable. This investigation is a part of the effort to establish the feasibility of using liquid centrifugation for nuclear waste separation in the Accelerator Driven Energy Production (ADEP) program. A number of fundatmental issues in liquid centrifugation with radioactive elements need to be addressed in order to validate the approach and provide design criteria for experimental liquid salt (LiF and BeF_2) centrifuge. The author concentrates on one such issue, the possible onset of convective instabilities which could inhibit separation.

29561 (LA-UR–95-17922, pp. 825) **Subcritical neutron generator-test facility for nuclear waste transmutation studies.** Chuvilo, I.V. (ITEP, Moscow (Russian Federation)); Kolomiets, A.A.; Kozodaev, A.M. Los Alamos National Lab., NM (United States). [1995]. (CONF-9407103–: International conference on accelerator-driven transmutation technologies and applications, Las Vegas, NV (United States), 25 Jul - 1 aug 1994). In *AIP conference on accelerator driven transmutation technologies and applications, Los Vegas, Nevada, July 25-29, 1994.* 958p. Order Number DE95014018. Source: OSTI; NTIS; INIS.

The development of the optimal design of high power facility for NPP transmutation and for a number of applications can not be carried out without preliminary tests of much cheaper prototypes. It has been proposed to combine in new test facility 36 MeV Linac ISTRA constructed in ITEP, original Be target and subcritical blanket that will be mounted on the place of partly disassembled heavy water ITEP experimental reactor. The basic parameters of Linac, schemes of the target and blanket are described. It will provide the direct experiments on installation which can be considered as prototype for future linac driven high power facilities.

29562 (LA-UR–95-17922, pp. 850) **Transmutation of fission products and actinide waste at Hanford.** Daemen, L.L. (Los Alamos National Laboratory, NM (United States)); Pitcher, E.J.; Russell, G.J. Los Alamos National Lab., NM (United States). [1995]. (CONF-9407103–: International conference on accelerator-driven transmutation technologies and applications, Las Vegas, NV (United States), 25 Jul - 1 aug 1994). In *AIP conference on accelerator driven transmutation technologies and applications, Los Vegas, Nevada, July 25-29, 1994.* 958p. Order Number DE95014018. Source: OSTI; NTIS; INIS.

The authors studied the neutronics of an ATW system for the transmutation of the fission products (^{99}Tc in particular) and the type of actinide waste stored in several tanks at Hanford. The heart of the system is a highly-efficient neutron production target. It is surrounded by a blanket containing a moderator/reflector material, as well as the products to be transmuted. The fission products are injected into the blanket in the form of an aqueous solution in heavy water, whereas an aqueous actinides slurry is circulated in the outer part of the blanket. For the sake of definiteness, the authors focussed on ^{99}Tc (the most difficult fission product to transmute), and ^{239}Pu, ^{237}Np, and ^{241}Am. Because of the low thermal neutron absorption cross-section of ^{99}Tc, considerable care and effort must be devoted to the design of a very efficient neutron source.

29563 (LA-UR–95-17922, pp. 858-863) **Some basic advantages of accelerator-driven transmutation of minor actinides and iodine-129.** Shmelev, A.N. (Moscow Engineering Physics Institute (Russian Federation)); Apse, V.A.; Kulikov, G.G. Los Alamos National Lab., NM (United States). [1995]. (CONF-9407103–: International conference on accelerator-driven transmutation technologies and applications, Las Vegas, NV (United States), 25 Jul - 1 aug 1994). In *AIP conference on accelerator driven transmutation technologies and applications, Los Vegas, Nevada, July 25-29, 1994.* 958p. Order Number DE95014018. Source: OSTI; NTIS; INIS.

The blanket of accelerator-driven facility designed for I-129 transmutation doesn't contain fissile and fertile materials. So the overheating of iodine compounds transmuted is practically excluded. The efficacy of I-129 transmutation is estimated. Curium being accumulated in nuclear reactors can be incinerated in blanket of accelerator-driven facility. The deep depletion of curium diluted with inert material can be achieved.

29564 (LA-UR–95-17922, pp. 877) **About the possibility of use of different types of targets as a neutron source for subcritical nuclear reactor driven by particle beam accelerator.** Avdeev, E.F. (Obninsk Institute of Nuclear Power Engineering (Russian Federation)); Dorokhovich, S.L.; Chusov, I.A. Los Alamos National Lab., NM (United States). [1995]. (CONF-9407103–: International conference on accelerator-driven transmutation technologies and applications, Las Vegas, NV (United States), 25 Jul - 1 aug 1994). In *AIP conference on accelerator driven transmutation technologies and applications, Los Vegas, Nevada, July 25-29, 1994.* 958p. Order Number DE95014018. Source: OSTI; NTIS; INIS.

The schemes of jet gas and liquid targets as well as the gastargets with a solid phase dispersion are introduced to use to receive the neutrons admitted to a subcritical reactor core. The possible variants of target position in the reactor are considered, target characteristics are calculated. The authors pay a great attention to the estimation of radioactive products yield receiving due to the interaction of the beam with the target.

29565 (LA-UR–95-17922, pp. 878-887) **Behavior of structural and target materials irradiated in spallation neutron environments.** Stubbins, J.F. (Univ. of Illinois, Urbana, IL (United States)); Wechsler, M.; Borden, M. Los Alamos National Lab., NM (United States). [1995]. (CONF-9407103–: International conference on accelerator-driven transmutation technologies and applications, Las Vegas, NV (United States), 25 Jul - 1 aug 1994). In *AIP conference on accelerator driven transmutation technologies and applications, Los Vegas, Nevada, July 25-29, 1994.* 958p. Order Number DE95014018. Source: OSTI; NTIS; INIS.

This paper describes considerations for selection of structural and target materials for accelerator-driven neutron sources. Due to the operating constraints of proposed accelerator-driven neutron sources, the criteria for selection are different than those commonly applied to fission and fusion systems. Established irradiation performance of various alloy systems is taken into account in the selection criteria. Nevertheless, only limited materials performance data are available which specifically related to neutron energy spectra anticipated for spallation sources.

29566 (LA-UR–95-17922, pp. 888) **Materials issues in nuclear environments: A history of unanticipated phenomena.** Garner, F.A. (Pacific Northwest Laboratory, Richland, WA (United States)). Los Alamos National Lab., NM (United States). [1995]. (CONF-9407103–: International conference on accelerator-driven transmutation technologies and applications, Las Vegas, NV (United States), 25 Jul - 1 aug 1994). In *AIP conference on accelerator driven transmutation technologies and applications, Los Vegas, Nevada, July 25-29, 1994.* 958p. Order Number DE95014018. Source: OSTI; NTIS; INIS.

The development of spallation neutron sources for plutonium conversion, transmutation of waste or energy production will most

likely lead to designs and/or materials that exceed the envelope of existing knowledge concerning the response of such materials in the new irradiation environment. If previous history can be used as a guide, it is inevitable that some previously unanticipated phenomenon will arise, requiring the development of an irradiation test program to define the behavior and limitations of the materials.

29567 (LA-UR–95-17922, pp. 941-943) **Summary of the target-blanket breakout group.** Capiello, M. (Los Alamos National Laboratory, NM (United States)); Bell, C.; Barthold, W. Los Alamos National Lab., NM (United States). [1995]. (CONF-9407103–: International conference on accelerator-driven transmutation technologies and applications, Las Vegas, NV (United States), 25 Jul - 1 aug 1994). In *AIP conference on accelerator driven transmutation technologies and applications, Los Vegas, Nevada, July 25-29, 1994.* 958p. Order Number DE95014018. Source: OSTI; NTIS; INIS.

This breakout group discussed a number of topics and issues pertaining to target and blanket concepts for accelerator-driven systems. This major component area is one marked by a broad spectrum of technical approaches. It is therefore less defined than other major component areas such as the accelerator and is at an earlier stage of technical needs and task specification. The working group did reach a number of general conclusions and recommendations that are summarized. The Conference and the Target/Blanket Breakout Group provided a first opportunity for people working on a variety of missions and concepts to get together and exchange information. A number of subcritical systems applicable for a spectrum of missions were proposed at the Conference and discussed in the Breakout Group. Missions included plutonium disposition, energy production, waste destruction, isotope production, and neutron scattering. The Target/Blanket Breakout Group also defined areas where parameters and data should be addressed as target/blanket design activities become more detailed and sophisticated.

29568 (LA-UR–95-17922, pp. 944-945) **Summary of the separations breakout group.** Jensen, R. (Los Alamos National Laboratory, NM (United States)). Los Alamos National Lab., NM (United States). [1995]. (CONF-9407103–: International conference on accelerator-driven transmutation technologies and applications, Las Vegas, NV (United States), 25 Jul - 1 aug 1994). In *AIP conference on accelerator driven transmutation technologies and applications, Los Vegas, Nevada, July 25-29, 1994.* 958p. Order Number DE95014018. Source: OSTI; NTIS; INIS.

The Separations Breakout Group reviewed the wide spectrum of separations technologies available for application to ADTT systems. Separations processes play a key role in areas associated with preparation of feed materials for introduction into ADTT, removal of fission products and other transmutation byproducts that build into the fuel during operation, and in the preparation of wastes ("polishing") for discharge from ADTT systems so as to meet appropriate waste disposal criteria. General separations technologies addressed by the group included aqueous, fluoride salt, and chloride salt approaches.

29569 (NUREG/CP–0142-Vol.4, pp. 2796-2805) **Flow characteristics of Korea multi-purpose research reactor.** Heonil Kim (Korea Atomic Energy Research Institute, Taejon (Korea, Republic of)); Hee Taek Chae; Byung Jin Jun; Ji Bok Lee. Nuclear Regulatory Commission, Washington, DC (United States). Div. of Systems Technology; American Nuclear Society, La Grange Park, IL (United States); American Inst. of Chemical Engineers, New York, NY (United States); American Society of Mechanical Engineers, New York, NY (United States); Canadian Nuclear Society, Toronto, ON (Canada); European Nuclear Society (ENS), Bern (Switzerland); Atomic Energy Society of Japan, Tokyo (Japan); Japan Society of Multiphase Flow, Kyoto (Japan). Sep 1995. (CONF-950904–Vol.4: 7. international meeting on nuclear reactor thermal hydraulics, Saratoga, NY (United States), 10-15 Sep 1995). In *Proceedings of the 7th International Meeting on Nuclear Reactor Thermal-Hydraulics NURETH-7. Sessions 17-24.* 825p. Source: OSTI; NTIS; INIS; GPO.

The construction of Korea Multi-purpose Research Reactor (KMRR), a 30 MW_{th} open-tank-in-pool type, is completed. Various thermal-hydraulic experiments have been conducted to verify the design characteristics of the KMRR. This paper describes the commissioning experiments to determine the flow distribution of KMRR core and the flow characteristics inside the chimney which stands on top of the core. The core flow is distributed to within ±6% of the average values, which is sufficiently flat in the sense that the design velocity in the fueled region is satisfied. The role of core bypass flow to confine the activated core coolant in the chimney structure is confirmed.

29570 (NUREG/CP–0142-Vol.4, pp. 2924-2940) **Natural circulation analysis for the advanced neutron source reactor refueling process 11.** Tucker, R.F. (Texas A&M Univ., Kingsville, TX (United States)); Dasardhi, S.; Elkassabgi, Y.; Yoder, G.L. Nuclear Regulatory Commission, Washington, DC (United States). Div. of Systems Technology; American Nuclear Society, La Grange Park, IL (United States); American Inst. of Chemical Engineers, New York, NY (United States); American Society of Mechanical Engineers, New York, NY (United States); Canadian Nuclear Society, Toronto, ON (Canada); European Nuclear Society (ENS), Bern (Switzerland); Atomic Energy Society of Japan, Tokyo (Japan); Japan Society of Multiphase Flow, Kyoto (Japan). Sep 1995. DOE Contract AC05-84OR21400. (CONF-950904–Vol.4: 7. international meeting on nuclear reactor thermal hydraulics, Saratoga, NY (United States), 10-15 Sep 1995). In *Proceedings of the 7th International Meeting on Nuclear Reactor Thermal-Hydraulics NURETH-7. Sessions 17-24.* 825p. Source: OSTI; NTIS; INIS; GPO.

During the refueling process of the Advanced Neutron Source Reactor (ANSR), the spent fuel elements must be moved from the primary coolant loop (containing D_2O), through a heavy water pool, and finally into a light water spent fuel storage area. The present refueling scheme utilizes remote refueling equipment to move the spent fuel elements through a D_2O filled stack and tunnel into a temporary storage canal. A transfer lock is used to move the spent fuel elements from the D_2O-filled interim storage canal to a light water pool. Each spent fuel element must be cooled during this process, using either natural circulation or forced convection. This paper presents a summary of the numerical techniques used to analyze natural circulation cooling of the ANSR fuel elements as well as selected results of the calculations. Details of the analysis indicate that coolant velocities below 10 cm/s exist in the coolant channels under single phase natural circulation conditions. Also, boiling does not occur within the channels if power levels are below a few hundred kW when the core transitions to natural circulation conditions.

29571 (NUREG/CP–0142-Vol.4, pp. 2941-2956) **Cold source vessel development for the advanced neutron source.** Williams, P.T. (Oak Ridge National Lab., TN (United States)); Lucas, A.T. Nuclear Regulatory Commission, Washington, DC (United States). Div. of Systems Technology; American Nuclear Society, La Grange Park, IL (United States); American Inst. of Chemical Engineers, New York, NY (United States); American Society of Mechanical Engineers, New York, NY (United States); Canadian Nuclear Society, Toronto, ON (Canada); European Nuclear Society (ENS), Bern (Switzerland); Atomic Energy Society of Japan, Tokyo (Japan); Japan Society of Multiphase Flow, Kyoto (Japan). Sep 1995. (CONF-950904–Vol.4: 7. international meeting on nuclear reactor thermal hydraulics, Saratoga, NY (United States), 10-15 Sep 1995). In *Proceedings of the 7th International Meeting on Nuclear Reactor Thermal-Hydraulics NURETH-7. Sessions 17-24.* 825p. Source: OSTI; NTIS; INIS; GPO.

The Advanced Neutron Source (ANS), in its conceptual design phase at Oak Ridge National Laboratory (ORNL), will be a user-oriented neutron research facility that will produce the most intense flux of neutrons in the world. Among its many scientific applications, the productions of cold neutrons is a significant research mission for the ANS. The cold neutrons come from two independent cold sources positioned near the reactor core. Contained by an aluminum alloy vessel, each cold source is a 410 mm diameter sphere of liquid deuterium that functions both as a neutron moderator and a cryogenic coolant. With nuclear heating of the containment vessel and internal baffling, steady-state operation requires close control of the liquid deuterium flow near the vessel's inner surface. Preliminary thermal-hydraulic analyses supporting

the cold source design are being performed with multi-dimensional computational fluid dynamics simulations of the liquid deuterium flow and heat transfer. This paper presents the starting phase of a challenging program and describes the cold source conceptual design, the thermal-hydraulic feasibility studies of the containment vessel, and the future computational and experimental studies that will be used to verify the final design.

29572 (ORNL/M–4306) **Meeting notes of the High Flux Isotope Reactor (HFIR) futures group.** Houser, M.M. (comp.). Oak Ridge National Lab., TN (United States). Aug 1995. 600p. Sponsored by USDOE, Washington, DC (United States). DOE Contract AC05-84OR21400. Order Number DE95017187. Source: OSTI; NTIS; INIS; GPO Dep.

Includes vugraphs.

This report is a compilation of the notes from the ten meetings. The group charter is: (1) to identify and characterize the range of possibilities and necessities for keeping the HFIR operating for at least the next 15 years; (2) to identify and characterize the range of possibilities for enhancing the scientific and technical utility of the HFIR; (3) to evaluate the benefits or impacts of these possibilities on the various scientific fields that use the HFIR or its products; (4) to evaluate the benefits or impacts on the operation and maintenance of the HFIR facility and the regulatory requirements; (5) to estimate the costs, including operating costs, and the schedules, including downtime, for these various possibilities; and one possible impact of proposed changes may be to stimulate increased pressure for a reduced enrichment fuel for HFIR.

29573 (ORNL/M–4324) **Fuel qualification plan for the Advanced Neutron Source Reactor.** Copeland, G.L. Oak Ridge National Lab., TN (United States). Jul 1995. 40p. Sponsored by USDOE, Washington, DC (United States). DOE Contract AC05-84OR21400. Order Number DE96000837. Source: OSTI; NTIS; INIS; GPO Dep.

This report describes the development and qualification plan for the fuel for the Advanced Neutron Source. The reference fuel is U_3Si_2, dispersed in aluminum and clad in 6061 aluminum. This report was prepared in May 1994, at which time the reference design was for a two-element core containing highly enriched uranium (93% ^{235}U) . The reactor was in the process of being redesigned to accommodate lowered uranium enrichment and became a three-element core containing a higher volume fraction of uranium enriched to 50% ^{235}U. Consequently, this report was not issued at that time and would have been revised to reflect the possibly different requirements of the lower-enrichment, higher-volume fraction fuel. Because the reactor is now being canceled, this unrevised report is being issued for archival purposes. The report describes the fabrication and inspection development plan, the irradiation tests and performance modeling to qualify performance, the transient testing that is part of the safety program, and the interactions and interfaces of the fuel development with other tasks.

29574 (ORNL/TM–13005) **Report of the ANS Project Feasibility Workshop for a High Flux Isotope Reactor-Center for Neutron Research Facility.** Peretz, F.J.; Booth, R.S. (comp.). Oak Ridge National Lab., TN (United States). Jul 1995. 30p. Sponsored by USDOE, Washington, DC (United States). DOE Contract AC05-84OR21400. Order Number DE95017192. Source: OSTI; NTIS; INIS; GPO Dep.

The Advanced Neutron Source (ANS) Conceptual Design Report (CDR) and its subsequent updates provided definitive design, cost, and schedule estimates for the entire ANS Project. A recent update to this estimate of the total project cost for this facility was $2.9 billion, as specified in the FY 1996 Congressional data sheet, reflecting a line-item start in FY 1995. In December 1994, ANS management decided to prepare a significantly lower-cost option for a research facility based on ANS which could be considered during FY 1997 budget deliberations if DOE or Congressional planners wished. A cost reduction for ANS of about $1 billion was desired for this new option. It was decided that such a cost reduction could be achieved only by a significant reduction in the ANS research scope and by maximum, cost-effective use of existing High Flux Isotope Reactor (HFIR) and ORNL facilities to minimize the need for new buildings. However, two central missions of the ANS – neutron scattering research and isotope production-were to be retained. The title selected for this new option was High Flux Isotope Reactor-Center for Neutron Research (HFIR-CNR) because of the project's maximum use of existing HFIR facilities and retention of selected, central ANS missions. Assuming this shared-facility requirement would necessitate construction work near HFIR, it was specified that HFIR-CNR construction should not disrupt normal operation of HFIR. Additional objectives of the study were that it be highly credible and that any material that might be needed for US Department of Energy (DOE) and Congressional deliberations be produced quickly using minimum project resources. This requirement made it necessary to rely heavily on the ANS design, cost, and schedule baselines. A workshop methodology was selected because assessment of each cost and/or scope-reduction idea required nearly continuous communication among project personnel to ensure that all ramifications of propsed changes.

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Refer also to citation(s) 28765, 28876, 28904, 29091, 29095, 29110, 29461, 29469, 29517, 29544, 30288, 30294

29575 (ANL/RE/CP–84097) **Evaluation of natural phenomena hazards as part of safety assessments for nuclear facilities.** Kot, C.A.; Hsieh, B.J.; Srinivasan, M.G.; Shin, Y.W. Argonne National Lab., IL (United States). Feb 1995. 9p. Sponsored by USDOE, Washington, DC (United States). DOE Contract W-31-109-ENG-38. (CONF-950804–6: 13. international conference on structural mechanics in reactor technology, Porto Alegre (Brazil), 13-18 Aug 1995). Order Number DE95014082. Source: OSTI; NTIS; INIS; GPO Dep.

The continued operation of existing US Department of Energy (DOE) nuclear facilities and laboratories requires a safety reassessment based on current criteria and guidelines. This also includes evaluations for the effects of Natural Phenomena Hazards (NPH), for which these facilities may not have been designed. The NPH evaluations follow the requirements of DOE Order 5480.28, Natural Phenomena Hazards Mitigation (1993) which establishes NPH Performance Categories (PCs) for DOE facilities and associated target probabilistic performance goals. These goals are expressed as the mean annual probability of exceedance of acceptable behavior for structures, systems and components (SSCs) subjected to NPH effects. The assignment of an NPH Performance Category is based on the overall hazard categorization (low, moderate, high) of a facility and on the function of an SSC under evaluation (DOE-STD-1021, 1992). Detailed guidance for the NPH analysis and evaluation criteria are also provided (DOE-STD-1020, 1994). These analyses can be very resource intensive, and may not be necessary for the evaluation of all SSCs in existing facilities, in particular for low hazard category facilities. An approach relying heavily on screening inspections, engineering judgment and use of NPH experience data (S. J. Eder et al., 1993), can minimize the analytical effort, give reasonable estimates of the NPH susceptibilities, and yield adequate information for an overall safety evaluation of the facility. In the following sections this approach is described in more detail and is illustrated by an application to a nuclear laboratory complex.

29576 (ANL/RE/CP–85604) **Uplift and rocking of a deformable body subject to base excitation.** Moran, T.J.; McLennan, G.A. Argonne National Lab., IL (United States). [1995]. 8p. Sponsored by USDOE, Washington, DC (United States). DOE Contract W-31-109-ENG-38. (CONF-950740–90: Joint ASME/JSME pressure vessels and piping conference, Honolulu, HI (United States), 23-27 Jul 1995). Order Number DE95014087. Source: OSTI; NTIS; GPO Dep.

The rolling and sliding motions of a rigid body subject to gravity and supported by a plane surface are treated in elementary texts on dynamics. Rocking of a riding body supported by a horizontal surface which experiences oscillatory accelerations due to an earthquake has been discussed by Housner. If the body is deformable there is a potential for the dynamics of the body deformations to couple with the rocking mode; in particular, resonances in the deformation response can develop sufficient reaction moment at the base to cause base uplift which would not occur if the body were rigid. The paper presents a model suitable for studying

this phenomena including the magnitude of the uplift, impacts occurring during stable rocking motions, and overturning. The equations governing the plane motion of a deformable body with rocking boundary conditions supported by a horizontal flat surface subject to vertical and horizontal accelerations are derived. These equations depend on dynamic parameters of the body which are defined in terms of integrals of assumed modes of deformation. The number of assumed modes is arbitrary. Motions which involve uplift but not overturning are termed rocking motions and are characterized by impacts with the supporting plane. Integration of these equations requires care in dealing with high frequency rocking motions may occur.

29577 (ANL/TD/CP–87020) **Experimental Boiling Water Reactor decontamination and decommissioning project.** Fellhauer, C. (Argonne National Lab., IL (United States). Technology Development Div.). Argonne National Lab., IL (United States). [1995]. 25p. Sponsored by USDOE, Washington, DC (United States). DOE Contract W-31109-ENG-38. (CONF-9505277–1-Vugraphs: Duke Engineering and Services, Inc. conference, Charlotte, NC (United States), 24 May 1995). Order Number DE95015638. Source: OSTI; NTIS; INIS; GPO Dep.

The author begins by discussing the problems encountered during decontamination and decommissioning. Next, he discusses waste packaging and recycling. His last topic of lessons learned is subdivided into prevention and early detection, recovery issues, management issues, and noteworthy practices.

29578 (BNL–61588) **Probabilistic wind/tornado/missile analyses for hazard and fragility evaluations.** Park, Y.J.; Reich, M. Brookhaven National Lab., Upton, NY (United States). [1995]. 11p. Sponsored by USDOE, Washington, DC (United States). DOE Contract AC02-76CH00016. (CONF-9511128–2: DOE natural phenomena hazards mitigation symposium, Denver, CO (United States), 13-14 Nov 1995). Order Number DE96000429. Source: OSTI; NTIS; GPO Dep.

Detailed analysis procedures and examples are presented for the probabilistic evaluation of hazard and fragility against high wind, tornado, and tornado-generated missiles. In the tornado hazard analysis, existing risk models are modified to incorporate various uncertainties including modeling errors. A significant feature of this paper is the detailed description of the Monte-Carlo simulation analyses of tornado-generated missiles. A simulation procedure, which includes the wind field modeling, missile injection, solution of flight equations, and missile impact analysis, is described with application examples.

29579 (CONF-941011–6) **Aging management of containment structures in nuclear power plants.** Naus, D.J. (Oak Ridge National Lab., TN (United States)); Oland, C.B.; Ellingwood, B.R.; Graves, H.L. III; Norris, W.E. Oak Ridge National Lab., TN (United States). [1994]. 15p. Sponsored by Nuclear Regulatory Commission, Washington, DC (United States). DOE Contract AC05-84OR21400. 1886-8084-5B. From 3. international conference on containment design and operation; Toronto (Canada); 19-21 Oct 1994. Source: OSTI; NTIS; INIS.

Research is being conducted by ORNL under US Nuclear Regulatory Commission (USNRC) sponsorship to address aging management of nuclear power plant containment and other safety-related structures. Documentation is being prepared to provide the USNRC with potential structural safety issues and acceptance criteria for use in continued service evaluations of nuclear power plants. Accomplishments include development of a Structural Materials Information Center containing data and information on the time variation of 144 material properties under the influence of pertinent environmental stressors or aging factors, evaluation of models for potential concrete containment degradation factors, development of a procedure to identify critical structures and degradation factors important to aging management, evaluations of nondestructive evaluation techniques. assessments of European and North American repair practices for concrete, review of parameters affecting corrosion of metals embedded in concrete, and development of methodologies for making current condition assessments and service life predictions of new or existing reinforced concrete structures in nuclear power plants.

29580 (CONF-950740–80) **Dynamic response of the high flux isotope reactor structure caused by nearby heavy load drop.** Chang, Shih-Jung. Oak Ridge National Lab., TN (United States). [1995]. 10p. Sponsored by USDOE, Washington, DC (United States). DOE Contract AC05-84OR21400. From Joint ASME/JSME pressure vessels and piping conference; Honolulu, HI (United States); 23-27 Jul 1995. Order Number DE95017404. Source: OSTI; NTIS; INIS; GPO Dep.

A heavy load of 50,000 lb is assumed to drop from 10 ft above the bottom of the High Flux Isotope Reactor (HFIR) pool at the loading station. The consequences of the dynamic impact to the bottom slab of the pool and to the nearby HFIR reactor vessel are analyzed by applying the ABAQUS computer code The results show that both the BM vessel structure and its supporting legs are subjected to elastic disturbances only and, therefore, will not be damaged. The bottom slab of the pool, however, will be damaged to about half of the slab thickness. The velocity response spectrum at the concrete floor next to the HFIR vessel as a result of the vibration caused by the impact is obtained. It is concluded, that the damage caused by heavy load drop at the loading station is controlled by the slab damage and the nearby HFIR vessel and the supporting legs will not be damaged.

29581 (INEL–95/00381) **Parameter uncertainty for ASP models.** Knudsen, J.K.; Smith, C.L. Lockheed Idaho Technologies Co., Idaho Falls, ID (United States). [1995]. 6p. Sponsored by Nuclear Regulatory Commission, Washington, DC (United States). DOE Contract AC07-94ID13223. (CONF-950914–7: American Nuclear Society international topical conference on the safety of operating reactors, Seattle, WA (United States), 17-23 Sep 1995). Order Number DE96001617. Source: OSTI; NTIS; INIS; GPO Dep.

The steps involved to incorporate parameter uncertainty into the Nuclear Regulatory Commission (NRC) accident sequence precursor (ASP) models is covered in this paper. Three different uncertainty distributions (i.e., lognormal, beta, gamma) were evaluated to Determine the most appropriate distribution. From the evaluation, it was Determined that the lognormal distribution will be used for the ASP models uncertainty parameters. Selection of the uncertainty parameters for the basic events is also discussed. This paper covers the process of determining uncertainty parameters for the supercomponent basic events (i.e., basic events that are comprised of more than one component which can have more than one failure mode) that are utilized in the ASP models. Once this is completed, the ASP model is ready to be utilized to propagate parameter uncertainty for event assessments.

29582 (JAERI-Conf–95-009, pp. 105-125) **A few reactor physics experiments related to the HTGR safety at VHTRC.** Yasuda, Hideshi (Japan Atomic Energy Research Inst., Tokai, Ibaraki (Japan). Tokai Research Establishment); Yamane, Tsuyoshi; Akino, Fujiyoshi. Japan Atomic Energy Research Inst., Tokyo (Japan). Mar 1995. (In Japanese). (CONF-9411223–: 3. JAERI seminar on HTGR technologies, Tokai (Japan), 7-8 Nov 1994). In *Proceedings of the third JAERI seminar on HTGR technologies.* 269p. Order Number DE95776544. Source: OSTI; NTIS; INIS.

Reactor physics experiments have been widely conducted at an HTGR-type critical assembly (Very High Temperature Reactor Critical Assembly, VHTRC) for the purpose of verifying the neutronic design of the High Temperature Engineering Test Reactor(HTTR) and also for improving the accuracy of safety-related reactor physics calculations of HTGRs. This paper introduces recent experimental works at the VHTRC. These works are of significant importance on the design and operation of practical HTGRs. The first subject describes an experiment simulating water ingress into an HTGR. Foamed polyethylene pellets were inserted in void regions in the core and reflector. Reactivity effects of the pellets were measured by a criticality method. The experimental results were compared with calculation results obtained by using SRAC code with the ENDF/B-IV based nuclear data library. The second subject describes an experiment on the VHTRC core partially inserted with an HTTR-mockup control rod. Thermal neutron flux distributions were measured by the foil activation method. The distribution were distorted strongly by the strong neutron absorption of the rod. Besides, Critical mass of ^{235}U for the core was also compared between experiment and calculation. The results are summarized in

the following: 1. The effect of water ingress into core region was well-estimated by the calculation. The effect of water ingress into the reflector region was very small. The calculation gave a comparatively poor guess to this effect. 2. Thermal neutron distribution was distorted very strongly by the partially-inserted control rod. The calculation gave a satisfactory guess. 3. Reactivity effect of partially-inserted control rod was predicted well by the calculation in spite of the uneven distribution of strong neutron absorption. (author).

29583 (LA-SUB–95-151) **Inherent safety advantages of carbide fuel systems and technical issues regarding natural convection in LMRs.** Barthold, W.P. (Barthold and Associates, Inc., Albuquerque, NM (United States)). Los Alamos National Lab., NM (United States); Barthold and Associates, Inc., Albuquerque, NM (United States). Aug 1984. 23p. Sponsored by USDOE, Washington, DC (United States);Department of Defense, Washington, DC (United States). DOE Contract W-7405-ENG-36. Order Number DE95017810. Source: OSTI; NTIS; GPO Dep.

The scope of work is to summarize inherent safety advantages that are unique to the use of a carbide based fuel system and to summarize the technical issues regarding natural convection flow in LMFBR cores. As discussed in this report, carbide fuel provides the designer with far greater flexibility than oxide fuel. Carbide fuel systems can be designed to eliminate major accident initiators. They turn quantitative advantages into a qualitative advantage. The author proposed to LANL a series of core design and component concepts that would greatly enhance the safety of carbide over oxide systems. This report cites a series of safety advantages which potentially exist for a carbide fuel system. Natural convection issues have not been given much attention in the past. Only during the last few years has this issue been addressed in some detail. Despite claims to the contrary by some of the LMR contractors, the author does not think that the natural convection phenomena is fully understood. Some of the approximations made in natural convection transient analyses have probably a greater impact on calculated transient temperatures than the effects under investigation. Only integral in-pile experimental data and single assembly out-of-pile detailed data are available for comparisons with analytical models and correlations. Especially for derated cores, the natural convection capability of a LMR should be far superior to that of a LWR. The author ranks the natural convection capability of the LMR as the most important inherent safety feature.

29584 (LA-SUB–95-175-A:1) **HFBR: Review of the technical specifications against the FSAR.** Rao, D.V. (Science and Engineering Associates, Inc., Albuquerque, NM (United States)); Boss, S.B.; Claiborne, E.R.; Darby, J.L.; Clark, R.A. Los Alamos National Lab., NM (United States); Science and Engineering Associates, Inc., Albuquerque, NM (United States). 25 Jan 1990. 35p. Sponsored by USDOE, Washington, DC (United States). DOE Contract W-7405-ENG-36. (SEA–90-500-02-A:1). Order Number DE96000822. Source: OSTI; NTIS; INIS; GPO Dep.

The purpose of this review is to determine the adequacy of the High Flux Beam Reactor (HFBR) Technical Specifications for 40 MW operation by comparison with the HFBR Final Safety Analysis Report, particularly the accident analyses chapter. Specifically, the Technical Specifications were compared against the Design Basis Accident (DBA) Analyses presented in the Addendum to the HFBR FSAR for 60 MW Operation. The 60 MW DBA analyses was used since it is more current and complete than the analyses presented in the original FSAR which is considered obsolete. A listing of the required systems and equipment was made for each of the accidents analyzed. Additionally, the Technical Specification instrument setpoints were compared to the DBA analyses parametric values. Also included in this review was a comparison of the Technical Specification Bases against the FSAR and the identification of any differences. The HFBR Operations Procedures Manual (OPM) was also reviewed for any inconsistencies between the FSAR or the Technical Specifications. Upon completion of this review it was determined that the Technical Specifications are well written and the items commented on should not delay the low power restart (40 MW). Additionally, the OPM is also well written and does not require further modification before restart.

29585 (LA-SUB–95-175-A:3) **HFBR restart activity A2.6: Review of FSAR and 60 MW addendum to assure consistency of operation at 40 MW.** Rao, D.V. (Science and Engineering Associates, Inc., Albuquerque, NM (United States)); Ross, S.B.; Darby, J.L.; Clark, R.A. Los Alamos National Lab., NM (United States); Science and Engineering Associates, Inc., Albuquerque, NM (United States). 26 Feb 1990. 17p. Sponsored by USDOE, Washington, DC (United States). DOE Contract W-7405-ENG-36. (SEA–90-500-02-A:3). Order Number DE96000823. Source: OSTI; NTIS; INIS; GPO Dep.

The purpose of this task (HFBR Restart Activity A2.6) is to perform a review of the design basis accident (DBA) analyses sections of the 1964 HFBR-Final Safety Analysis Report; Volumes I and II, and the 1982 Addendum to the HFBR-FSAR for 60 MW operation to assure that operation at 40 MW will be consistent with these analyses. Additional documents utilized in the review included the Level 1 PRA for HFBR, HFBR-PDMs and HFBR-OPMs. The review indicates that the 1964 FSAR-DBA analysis in incomplete in the sense that it did not analyze some of the important initiators for 1-loop operation that include: Accidental throttling of primary flow control valves; seizure of primary pump; loss of secondary pump; accidental throttling of secondary flow control valves; rupture of secondary piping. The first three initiators were later studied in the 1982 addendum. The other two initiators have not been examined to-date for 1-loop operation. It is recommended that the impact of these initiators be assessed prior to the restart, if 1-loop operation is chosen for the restart. The review demonstrated that at 40 MW operation there are only a few accident initiators that will culminate in core damage (fuel melting and /or cladding failure) regardless of the availability of mitigating systems. For 1-loop Operation these accidents include: Fuel channel blockage, primary pump seizure, and large-large LOCA (a LOCA with effective break diameter > 2.81 in. is referred to as a large-large LOCA in this document as well as in PRA). Although all these accidents listed above could lead to core damage for 1-loop operation as well, the probability is expected be very low.

29586 (LA-SUB–95-175-A:5) **Determination of maximum reactor power level consistent with the requirement that flow reversal occurs without fuel damage.** Rao, D.V. (Science and Engineering Associates, Inc., Albuquerque, NM (United States)); Darby, J.L.; Ross, S.B.; Clark, R.A. Los Alamos National Lab., NM (United States); Science and Engineering Associates, Inc., Albuquerque, NM (United States). 19 Apr 1990. 90p. Sponsored by USDOE, Washington, DC (United States). DOE Contract W-7405-ENG-36. (SEA–90-500-02-A:5). Order Number DE96000824. Source: OSTI; NTIS; INIS; GPO Dep.

The High Flux Beam Reactor (HFBR) operated by Brookhaven National Laboratory (BNL) employs forced downflow for heat removal during normal operation. In the event of total loss of forced flow, the reactor will shutdown and the flow reversal valves open. When the downward core flow becomes sufficiently small then the opposing thermal buoyancy induces flow reversal leading to decay heat removal by natural convection. There is some uncertainty as to whether the natural circulation is adequate for decay heat removal after 60 MW operation. BNL- staff carried out a series of calculations to establish the adequacy of flow reversal to remove decay heat. Their calculations are based on a natural convective CHF model. The primary purpose of the present calculations is to review the accuracy and applicability of Fauske's CHF model for the HFBR, and the assumptions and methodology employed by BNL-staff to determine the heat removal limit in the HFBR during a flow reversal and natural convection situation.

29587 (LA-UR–95-1785) **Intermediate-break LOCA analyses for the AP600 design.** Boyack, B.E.; Lime, J.F. Los Alamos National Lab., NM (United States). [1995]. 69p. Sponsored by Nuclear Regulatory Commission, Washington, DC (United States). DOE Contract W-7405-ENG-36. Order Number DE95015318. Source: OSTI; NTIS; INIS; GPO Dep.

A postulated double-ended guillotine break of a direct-vessel-injection line in an AP600 plant has been analyzed. This event is characterized as an intermediate break loss-of-coolant accident (IBLOCA). Most of the insights regarding the response of the AP600 safety systems to the postulated accident are derived from

calculations performed with the TRAC-PF/MOD2 code. However, complementary insights derived from a scaled experiment conducted in the ROSA facility, as well as insights based upon calculations by other codes, are also presented. The key processes occurring in an AP600 during a IBLOCA are primary coolant system depressurization, inventory depletion, inventory replacement via emergency core coolant injection, continuous core cooling, and long-term decay heat rejection to the atmosphere. Based upon the calculated and experimental results, the AP600 will not experience a core heat up and will reach a safe shutdown state using only safety-class equipment. Only the early part of the long-term cooling period initiated by In-containment Refueling Water Storage Tank injection was evaluated Thus, the observation that the core is continuously cooled should be verified for the latter phase of the long-term cooling period, the interval when sump injection and containment cooling processes are important.

29588 (LA-UR–95-17922, pp. 158-165) **Safety and control of accelerator-driven subcritical systems.** Rief, H. (Ispra Establishment (Italy)); Takahashi, H. Los Alamos National Lab., NM (United States). [1995]. (CONF-9407103–: International conference on accelerator-driven transmutation technologies and applications, Las Vegas, NV (United States), 25 Jul - 1 aug 1994). In *AIP conference on accelerator driven transmutation technologies and applications, Los Vegas, Nevada, July 25-29, 1994.* 958p. Order Number DE95014018. Source: OSTI; NTIS; INIS.

To study control and safety of accelertor driven nuclear systems, a one point kinetic model was developed and programed. It deals with fast transients as a function of reactivity insertion. Doppler feedback, and the intensity of an external neutron source. The model allows for a simultaneous calculation of an equivalent critical reactor. It was validated by a comparison with a benchmark specified by the Nuclear Energy Agency Committee of Reactor Physics. Additional features are the possibility of inserting a linear or quadratic time dependent reactivity ramp which may account for gravity induced accidents like earthquakes, the possibility to shut down the external neutron source by an exponential decay law of the form $\exp(-t/\tau)$, and a graphical display of the power and reactivity changes. The calculations revealed that such boosters behave quite benignly even if they are only slightly subcritical.

29589 (LA-UR–95-17922, pp. 166-175) **Safety features of subcritical fluid fueled systems.** Bell, C.R. (Los Alamos National Laboratory, NM (United States)). Los Alamos National Lab., NM (United States). [1995]. (CONF-9407103–: International conference on accelerator-driven transmutation technologies and applications, Las Vegas, NV (United States), 25 Jul - 1 aug 1994). In *AIP conference on accelerator driven transmutation technologies and applications, Los Vegas, Nevada, July 25-29, 1994.* 958p. Order Number DE95014018. Source: OSTI; NTIS; INIS.

Accelerator-driven transmutation technology has been under study at Los Alamos for several years for application to nuclear waste treatment, tritium production, energy generation, and recently, to the disposition of excess weapons plutonium. Studies and evaluations performed to date at Los Alamos have led to a current focus on a fluid-fuel, fission system operating in a neutron source-supported subcritical mode, using molten salt reactor technology and accelerator-driven proton-neutron spallation. In this paper, the safety features and characteristics of such systems are explored from the perspective of the fundamental nuclear safety objectives that any reactor-type system should address. This exploration is qualitative in nature and uses current vintage solid-fueled reactors as a baseline for comparison. Based on the safety perspectives presented, such systems should be capable of meeting the fundamental nuclear safety objectives. In addition, they should be able to provide the safety robustness desired for advanced reactors. However, the manner in which safety objectives and robustness are achieved is very different from that associated with conventional reactors. Also, there are a number of safety design and operational challenges that will have to be addressed for the safety potential of such systems to be credible.

29590 (LA-UR–95-17922, pp. 716-722) **Some nuclear safety aspects of the Los Alamos accelerator based converion concept.** Gudowski, W. (Royal Institute of Technology, Stockholm (Sweden)); Moeller, E.; Venneri, F. Los Alamos National Lab., NM (United States). [1995]. (CONF-9407103–: International conference on accelerator-driven transmutation technologies and applications, Las Vegas, NV (United States), 25 Jul - 1 aug 1994). In *AIP conference on accelerator driven transmutation technologies and applications, Los Vegas, Nevada, July 25-29, 1994.* 958p. Order Number DE95014018. Source: OSTI; NTIS; INIS.

The detailed analysis of the few parameters important for the safety of the accelerator-driven plutonium burner concept developed at Los Alamos National Laboratory was performed. The plutonium loac. optimal thermalization of the neutron spectrum and temperature reactivity coefficients were investigated. The calculations revealed the strong positive temperature reactivity coeffecient. The ways to solve this problem are suggested.

29591 (LA-UR–95-17922, pp. 728-736) **The neutronics of an Accelerator-Driven Energy Amplifier.** Moeller, E. (Royal Institute of Technology, Stockholm (Sweden)); Gudowski, W. Los Alamos National Lab., NM (United States). [1995]. (CONF-9407103–: International conference on accelerator-driven transmutation technologies and applications, Las Vegas, NV (United States), 25 Jul - 1 aug 1994). In *AIP conference on accelerator driven transmutation technologies and applications, Los Vegas, Nevada, July 25-29, 1994.* 958p. Order Number DE95014018. Source: OSTI; NTIS; INIS.

This study has been focused on an Accelerator-Driven Energy Amplifier, based on the concept proposed by the CERN-group. To analyze the performance of this system the extensive optimization of the core lattice was done, the temperature coefficients of reactivity were investigated, reactivity budget and power distribution were estimated.

29592 (NUREG–0090-Vol.17-No.4) **Report to Congress on abnormal occurrences, October–December 1994. Volume 17, No. 4.** Nuclear Regulatory Commission, Washington, DC (United States). Office for Analysis and Evaluation of Operational Data. May 1995. 37p. Sponsored by Nuclear Regulatory Commission, Washington, DC (United States). Source: OSTI; NTIS; INIS; GPO.

Section 208 of the Energy Reorganization Act of 1974 identifies an abnormal occurrence (AO) as an unscheduled incident or event that the Nuclear Regulatory Commission determines to be significant from the standpoint of public health or safety and requires a quarterly report of such occurrences to be made to Congress. This report provides a description of those incidents and events that have been determined to be AOs during the period of October 1 through December 31, 1994. This report addresses four AOs at NRC-licensed facilities. These occurrences involved the following: a generic concern relating to core shroud cracking in boiling water reactors; recurring incidents of administering higher doses than procedurally allowed for diagnostic imaging at a single facility; one medical teletherapy misadministration; and one medical brachytherapy misadministration. Agreement States submitted four AO reports. These four occurrences involved the following: one major contamination at a commercial facility; two medical brachytherapy misadministrations; and one medical teletherapy misadministration. The report also contains updates of seven AOs previously reported by NRC licensees and four AOs previously reported by the Agreement States. Two "Other Events of Interest" are also being reported. These occurrences involved the operability of safety relief valves at a nuclear power plant, and an error in the installation process of a Leksell Gamma KnifeR teletherapy unit that resulted in an operational failure.

29593 (NUREG/CP–0138, pp. 13-22) **A commentary on model uncertainty.** Apostolakis, G. (Univ. of California, Los Angeles, CA (United States)). Nuclear Regulatory Commission, Washington, DC (United States). Div. of Safety Issue Resolution; Maryland Univ., College Park, MD (United States); EG and G Idaho, Inc., Idaho Falls, ID (United States). Oct 1994. (CONF-9310377–: Advanced topics in risk and reliability analysis, Annapolis, MD (United States), 20 Oct 1993). In *Proceedings of workshop I in advanced topics in risk and reliability analysis. Model uncertainty: Its characterization and quantification.* 242p. Source: OSTI; NTIS; INIS; GPO.

A framework is proposed for the identification of model and parameter uncertainties in risk assessment models. Two cases are

distinguished; in the first case, a set of mutually exclusive and exhaustive hypotheses (models) can be formulated, while, in the second, only one reference model is available. The relevance of this formulation to decision making and the communication of uncertainties is discussed.

29594 (NUREG/CP–0138, pp. 23-29) **Model uncertainty and probability.** Parry, G.W. (NUS Corp., Gaithersburg, MD (United States)). Nuclear Regulatory Commission, Washington, DC (United States). Div. of Safety Issue Resolution; Maryland Univ., College Park, MD (United States); EG and G Idaho, Inc., Idaho Falls, ID (United States). Oct 1994. (CONF-9310377–: Advanced topics in risk and reliability analysis, Annapolis, MD (United States), 20 Oct 1993). In *Proceedings of workshop I in advanced topics in risk and reliability analysis. Model uncertainty: Its characterization and quantification.* 242p. Source: OSTI; NTIS; INIS; GPO.

This paper discusses the issue of model uncertainty. The use of probability as a measure of an analyst's uncertainty as well as a means of describing random processes has caused some confusion, even though the two uses are representing different types of uncertainty with respect to modeling a system. The importance of maintaining the distinction between the two types is illustrated with a simple example.

29595 (NUREG/CP–0138, pp. 31-40) **Implications of model uncertainty for the practice of risk assessment.** Laskey, K.B. (George Mason Univ., Fairfax, VA (United States)). Nuclear Regulatory Commission, Washington, DC (United States). Div. of Safety Issue Resolution; Maryland Univ., College Park, MD (United States); EG and G Idaho, Inc., Idaho Falls, ID (United States). Oct 1994. (CONF-9310377–: Advanced topics in risk and reliability analysis, Annapolis, MD (United States), 20 Oct 1993). In *Proceedings of workshop I in advanced topics in risk and reliability analysis. Model uncertainty: Its characterization and quantification.* 242p. Source: OSTI; NTIS; INIS; GPO.

A model is a representation of a system that can be used to answer questions about the system's behavior. The term model uncertainty refers to problems in which there is no generally agreed upon, validated model that can be used as a surrogate for the system itself. Model uncertainty affects both the methodology appropriate for building models and how models should be used. This paper discusses representations of model uncertainty, methodologies for exercising and interpreting models in the presence of model uncertainty, and the appropriate use of fallible models for policy making.

29596 (NUREG/CP–0138, pp. 41-50) **A Bayesian approach to model uncertainty.** Buslik, A. (Nuclear Regulatory Commission, Washington, D.C. (United States)). Nuclear Regulatory Commission, Washington, DC (United States). Div. of Safety Issue Resolution; Maryland Univ., College Park, MD (United States); EG and G Idaho, Inc., Idaho Falls, ID (United States). Oct 1994. (CONF-9310377–: Advanced topics in risk and reliability analysis, Annapolis, MD (United States), 20 Oct 1993). In *Proceedings of workshop I in advanced topics in risk and reliability analysis. Model uncertainty: Its characterization and quantification.* 242p. Source: OSTI; NTIS; INIS; GPO.

A Bayesian approach to model uncertainty is taken. For the case of a finite number of alternative models, the model uncertainty is equivalent to parameter uncertainty. A derivation based on Savage's partition problem is given.

29597 (NUREG/CP–0138, pp. 51-64) **Aspects of modeling uncertainty and prediction.** McKay, M.D. (Los Alamos National Lab., NM (United States)). Nuclear Regulatory Commission, Washington, DC (United States). Div. of Safety Issue Resolution; Maryland Univ., College Park, MD (United States); EG and G Idaho, Inc., Idaho Falls, ID (United States). Oct 1994. (CONF-9310377–: Advanced topics in risk and reliability analysis, Annapolis, MD (United States), 20 Oct 1993). In *Proceedings of workshop I in advanced topics in risk and reliability analysis. Model uncertainty: Its characterization and quantification.* 242p. Source: OSTI; NTIS; INIS; GPO.

Probabilistic assessment of variability in model prediction considers input uncertainty and structural uncertainty. For input uncertainty, understanding of practical origins of probabilistic treatments as well as restrictions and limitations of methodology is much more developed than for structural uncertainty. There is a simple basis for structural uncertainty which parallels that for input uncertainty. Although methodologies for assessing structural uncertainty for models in general are very limited, more options are available to address submodels.

29598 (NUREG/CP–0138, pp. 65-89) **Uncertainty and its propagation in dynamics models.** Devooght, J. (Universite Libre de Bruxelles, Brussels (Belgium)). Nuclear Regulatory Commission, Washington, DC (United States). Div. of Safety Issue Resolution; Maryland Univ., College Park, MD (United States); EG and G Idaho, Inc., Idaho Falls, ID (United States). Oct 1994. (CONF-9310377–: Advanced topics in risk and reliability analysis, Annapolis, MD (United States), 20 Oct 1993). In *Proceedings of workshop I in advanced topics in risk and reliability analysis. Model uncertainty: Its characterization and quantification.* 242p. Source: OSTI; NTIS; INIS; GPO.

The purpose of this paper is to bring together some characteristics due to uncertainty when we deal with dynamic models and therefore to propagation of uncertainty. The respective role of uncertainty and inaccuracy is examined. A mathematical formalism based on Chapman-Kolmogorov equation allows to define a "subdynamics" where the evolution equation takes the uncertainty into account. The problem of choosing or combining models is examined through a loss function associated to a decision.

29599 (NUREG/CP–0138, pp. 91-98) **Some illustrative examples of model uncertainty.** Bier, V.M. (Univ. of Wisconsin, Madison, WI (United States)). Nuclear Regulatory Commission, Washington, DC (United States). Div. of Safety Issue Resolution; Maryland Univ., College Park, MD (United States); EG and G Idaho, Inc., Idaho Falls, ID (United States). Oct 1994. (CONF-9310377–: Advanced topics in risk and reliability analysis, Annapolis, MD (United States), 20 Oct 1993). In *Proceedings of workshop I in advanced topics in risk and reliability analysis. Model uncertainty: Its characterization and quantification.* 242p. Source: OSTI; NTIS; INIS; GPO.

In this paper, we first discuss the view of model uncertainty proposed by Apostolakis. We then present several illustrative examples related to model uncertainty, some of which are not well handled by this formalism. Thus, Apostolakis' approach seems to be well suited to describing some types of model uncertainty, but not all. Since a comprehensive approach for characterizing and quantifying model uncertainty is not yet available, it is hoped that the examples presented here will service as a springboard for further discussion.

29600 (NUREG/CP–0138, pp. 99-105) **Individual model evaluation and probabilistic weighting of models.** Atwood, C.L. (Idaho National Engineering Lab., Idaho Falls, ID (United States)). Nuclear Regulatory Commission, Washington, DC (United States). Div. of Safety Issue Resolution; Maryland Univ., College Park, MD (United States); EG and G Idaho, Inc., Idaho Falls, ID (United States). Oct 1994. DOE Contract AC07-76ID01570. (CONF-9310377–: Advanced topics in risk and reliability analysis, Annapolis, MD (United States), 20 Oct 1993). In *Proceedings of workshop I in advanced topics in risk and reliability analysis. Model uncertainty: Its characterization and quantification.* 242p. Source: OSTI; NTIS; INIS; GPO.

This note stresses the importance of trying to assess the accuracy of each model individually. Putting a Bayesian probability distribution on a population of models faces conceptual and practical complications, and apparently can come only after the work of evaluating the individual models. Moreover, the primary issue is "How good is this model"? Therefore, the individual evaluations are first in both chronology and importance. They are not easy, but some ideas are given here on how to perform them.

29601 (NUREG/CP–0138, pp. 107-116) **Model uncertainty: Probabilities for models.** Winkler, R.L. (Duke Univ., Durham, NC (United States)). Nuclear Regulatory Commission, Washington, DC (United States). Div. of Safety Issue Resolution; Maryland Univ., College Park, MD (United States); EG and G Idaho, Inc., Idaho Falls, ID (United States). Oct 1994. Grant SES-9022616;

Grant SBR-9320662. (CONF-9310377–: Advanced topics in risk and reliability analysis, Annapolis, MD (United States), 20 Oct 1993). In *Proceedings of workshop I in advanced topics in risk and reliability analysis. Model uncertainty: Its characterization and quantification.* 242p. Source: OSTI; NTIS; INIS; GPO.

Like any other type of uncertainty, model uncertainty should be treated in terms of probabilities. The question is how to do this. The most commonly-used approach has a drawback related to the interpretation of the probabilities assigned to the models. If we step back and look at the big picture, asking what the appropriate focus of the model uncertainty question should be in the context of risk and decision analysis, we see that a different probabilistic approach makes more sense, although it raise some implementation questions. Current work that is underway to address these questions looks very promising.

29602 (NUREG/CP–0138, pp. 119-123) **Model uncertainty from a regulatory point of view.** Abramson, L.R. (Nuclear Regulatory Commission, Washington, DC (United States)). Nuclear Regulatory Commission, Washington, DC (United States). Div. of Safety Issue Resolution; Maryland Univ., College Park, MD (United States); EG and G Idaho, Inc., Idaho Falls, ID (United States). Oct 1994. (CONF-9310377–: Advanced topics in risk and reliability analysis, Annapolis, MD (United States), 20 Oct 1993). In *Proceedings of workshop I in advanced topics in risk and reliability analysis. Model uncertainty: Its characterization and quantification.* 242p. Source: OSTI; NTIS; INIS; GPO.

This paper discusses model uncertainty in the larger context of knowledge and random uncertainty. It explores some regulatory implications of model uncertainty and argues that, from a regulator's perspective, a conservative approach must be taken. As a consequence of this perspective, averaging over model results is ruled out.

29603 (NUREG/CP–0138, pp. 125-133) **Dealing with phenomenological uncertainty in risk analysis.** Theofanous, T.G. (Univ. of California, Santa Barbara, CA (United States)). Nuclear Regulatory Commission, Washington, DC (United States). Div. of Safety Issue Resolution; Maryland Univ., College Park, MD (United States); EG and G Idaho, Inc., Idaho Falls, ID (United States). Oct 1994. (CONF-9310377–: Advanced topics in risk and reliability analysis, Annapolis, MD (United States), 20 Oct 1993). In *Proceedings of workshop I in advanced topics in risk and reliability analysis. Model uncertainty: Its characterization and quantification.* 242p. Source: OSTI; NTIS; INIS; GPO.

The Risk-Oriented Accident Analysis Methodology (ROAAM) is summarized and developed further towards a formal definition. The key ideas behind the methodology and these more formal aspects are also presented and discussed.

29604 (NUREG/CP–0138, pp. 135-150) **Computerized fire risk assessment models: A regulatory effectiveness analysis.** Brannigan, V. (Univ. of Maryland, College Park, MD (United States)); Meeks, C. Nuclear Regulatory Commission, Washington, DC (United States). Div. of Safety Issue Resolution; Maryland Univ., College Park, MD (United States); EG and G Idaho, Inc., Idaho Falls, ID (United States). Oct 1994. (CONF-9310377–: Advanced topics in risk and reliability analysis, Annapolis, MD (United States), 20 Oct 1993). In *Proceedings of workshop I in advanced topics in risk and reliability analysis. Model uncertainty: Its characterization and quantification.* 242p. Source: OSTI; NTIS; INIS; GPO.

Computerized fire risk assessment models have been proposed for regulatory use. Regulatory Effectiveness Analysis is a tool which can be used to determine whether the model satisfies the regulator's legal requirements, and whether it is properly responsive to public judgments of fire safety. Model builders should expect detailed examination of the specifications and data used in the model, and be prepared to show competent verification and validation of the model results.

29605 (NUREG/CP–0138, pp. 151-165) **Addressing model uncertainty in dose-response: The case of chloroform.** Evans, J.S. (Harvard School of Public Health, Boston, MA (United States)). Nuclear Regulatory Commission, Washington, DC (United States). Div. of Safety Issue Resolution; Maryland Univ., College Park, MD (United States); EG and G Idaho, Inc., Idaho Falls, ID (United States). Oct 1994. (CONF-9310377–: Advanced topics in risk and reliability analysis, Annapolis, MD (United States), 20 Oct 1993). In *Proceedings of workshop I in advanced topics in risk and reliability analysis. Model uncertainty: Its characterization and quantification.* 242p. Source: OSTI; NTIS; INIS; GPO.

This paper discusses the issues involved in addressing model uncertainty in the analysis of dose-response relationships. A method for addressing model uncertainty is described and applied to characterize the uncertainty in estimates of the carcinogenic potency of chloroform. The approach, which is rooted in Bayesian concepts of subjective probability, uses probability trees and formally-elicited expert judgments to address model uncertainty. It is argued that a similar approach could be used to improve the characterization of model uncertainty in the dose-response relationships for health effects from ionizing radiation.

29606 (NUREG/CP–0138, pp. 187-196) **On the estimation of failure rates for living PSAs in the presence of model uncertainty.** Arsenis, S.P. (Institute for Systems Engineering and Informatics, Ispra (Italy)). Nuclear Regulatory Commission, Washington, DC (United States). Div. of Safety Issue Resolution; Maryland Univ., College Park, MD (United States); EG and G Idaho, Inc., Idaho Falls, ID (United States). Oct 1994. Contract 3842-89-11 TG ISP I. (CONF-9310377–: Advanced topics in risk and reliability analysis, Annapolis, MD (United States), 20 Oct 1993). In *Proceedings of workshop I in advanced topics in risk and reliability analysis. Model uncertainty: Its characterization and quantification.* 242p. Source: OSTI; NTIS; INIS; GPO.

The estimation of failure rates of heterogeneous Poisson components from data on times operated to failures is reviewed. Particular emphasis is given to the lack of knowledge on the form of the mixing distribution or population variability curve. A new nonparametric epirical Bayes estimation is proposed which generalizes the estimator of Robbins for different times of observations for the components. The behavior of the estimator is discussed by reference to two samples typically drawn from the CEDB, a component event database designed and operated by the Ispra JRC.

29607 (NUREG/CP–0138, pp. 197-208) **Empirical Bayesian inference and model uncertainty.** Poern, K. (Poern Consulting, Nykoeping (Sweden)). Nuclear Regulatory Commission, Washington, DC (United States). Div. of Safety Issue Resolution; Maryland Univ., College Park, MD (United States); EG and G Idaho, Inc., Idaho Falls, ID (United States). Oct 1994. (CONF-9310377–: Advanced topics in risk and reliability analysis, Annapolis, MD (United States), 20 Oct 1993). In *Proceedings of workshop I in advanced topics in risk and reliability analysis. Model uncertainty: Its characterization and quantification.* 242p. Source: OSTI; NTIS; INIS; GPO.

This paper presents a hierarchical or multistage empirical Bayesian approach for the estimation of uncertainty concerning the intensity of a homogeneous Poisson process. A class of contaminated gamma distributions is considered to describe the uncertainty concerning the intensity. These distributions in turn are defined through a set of secondary parameters, the knowledge of which is also described and updated via Bayes formula. This two-stage Bayesian approach is an example where the modeling uncertainty is treated in a comprehensive way. Each contaminated gamma distributions, represented by a point in the 3D space of secondary parameters, can be considered as a specific model of the uncertainty about the Poisson intensity. Then, by the empirical Bayesian method each individual model is assigned a posterior probability.

29608 (NUREG/CP–0138, pp. 209-224) **Statistics of past errors as a source of safety factors for current models.** Shlyakhter, A.I. (Harvard Univ., Cambridge, MA (United States)). Nuclear Regulatory Commission, Washington, DC (United States). Div. of Safety Issue Resolution; Maryland Univ., College Park, MD (United States); EG and G Idaho, Inc., Idaho Falls, ID (United States). Oct 1994. (CONF-9310377–: Advanced topics in risk and reliability analysis, Annapolis, MD (United States), 20 Oct 1993). In *Proceedings of workshop I in advanced topics in risk and reliability analysis. Model uncertainty: Its characterization and quantification.* 242p. Source: OSTI; NTIS; INIS; GPO.

Results of a comparative analysis of actual vs. estimated uncertainty in several data sets derived from natural and social sciences are presented. Data sets include: (i) time trends in the sequential measurements of the same physical quantity; (ii) environmental measurements of uranium in soil, (iii) national population projections; (iv) projections for the United States' energy sector. Probabilities of large deviations from the true values are parametrized by an exponential distribution with the slope determined by the data. One can hedge against unsuspected uncertainties by inflating reported uncertainty range by a default safety factor determined from the relevant historical data sets. This emperical approach can be used in the uncertainty analysis of the low probability/high consequence events, such as risk of global warming.

29609 (NUREG/CP–0142-Vol.1, pp. 1-20) **Turning points in reactor design.** Beckjord, E.S. Nuclear Regulatory Commission, Washington, DC (United States). Div. of Systems Technology; American Nuclear Society, La Grange Park, IL (United States); American Inst. of Chemical Engineers, New York, NY (United States); American Society of Mechanical Engineers, New York, NY (United States); Canadian Nuclear Society, Toronto, ON (Canada); Japan Society of Multiphase Flow, Kyoto (Japan). Sep 1995. (CONF-950904–Vol.1: 7. international meeting on nuclear reactor thermal hydraulics, Saratoga, NY (United States), 10-15 Sep 1995). In *Proceedings of the 7th International Meeting on Nuclear Reactor Thermal-Hydraulics NURETH-7. Volume 1, Sessions 1-5.* 862p. Source: OSTI; NTIS; INIS; GPO.

This article provides some historical aspects on nuclear reactor design, beginning with PWR development for Naval Propulsion and the first commercial application at Yankee Rowe. Five turning points in reactor design and some safety problems associated with them are reviewed: (1) stability of Dresden-1, (2) ECCS, (3) PRA, (4) TMI-2, and (5) advanced passive LWR designs. While the emphasis is on the thermal-hydraulic aspects, the discussion is also about reactor systems.

29610 (NUREG/CP–0142-Vol.1, pp. 21-42) **Resolution of thermal-hydraulic safety and licensing issues for the system 80+™ design.** Carpentino, S.E. (ABB-Combustion Engineering, Windsor, CT (United States)); Ritterbusch, S.E.; Schneider, R.E. Nuclear Regulatory Commission, Washington, DC (United States). Div. of Systems Technology; American Nuclear Society, La Grange Park, IL (United States); American Inst. of Chemical Engineers, New York, NY (United States); American Society of Mechanical Engineers, New York, NY (United States); Canadian Nuclear Society, Toronto, ON (Canada); Japan Society of Multiphase Flow, Kyoto (Japan). Sep 1995. (CONF-950904–Vol.1: 7. international meeting on nuclear reactor thermal hydraulics, Saratoga, NY (United States), 10-15 Sep 1995). In *Proceedings of the 7th International Meeting on Nuclear Reactor Thermal-Hydraulics NURETH-7. Volume 1, Sessions 1-5.* 862p. Source: OSTI; NTIS; INIS; GPO.

The System 80+™ Standard Design is an evolutionary Advanced Light Water Reactor (ALWR) with a generating capacity of 3931 MWt (1350 MWe). The Final Design Approval (FDA) for this design was issued by the Nuclear Regulatory Commission (NRC) in July 1994. The design certification by the NRC is anticipated by the end of 1995 or early 1996. NRC review of the System 80+ design has involved several new safety issues never before addressed in a regulatory atmosphere. In addition, conformance with the Electric Power Research Institute (EPRI) ALWR Utility Requirements Document (URD) required that the System 80+ plant address nuclear industry concerns with regard to design, construction, operation and maintenance of nuclear power plants. A large number of these issues/concerns deals with previously unresolved generic thermal-hydraulic safety issues and severe accident prevention and mitigation. This paper discusses the thermal-hydraulic analyses and evaluations performed for the System 80+ design to resolve safety and licensing issues relevant to both the Nuclear Stream Supply System (NSSS) and containment designs. For the NSSS design, the Safety Depressurization System mitigation capability and resolution of the boron dilution concern are described. Examples of containment design issues dealing with containment shell strength, robustness of the reactor cavity walls and hydrogen mixing under severe accident conditions are also provided. Finally, the overall approach used in the application of NRC's new (NUREG-1465) radiological source term for System 80+ evaluation is described. The robustness of the System 80+ containment design to withstand severe accident consequences was demonstrated through detailed thermal-hydraulic analyses and evaluations. This advanced design to shown to meet NRC severe accident policy goals and ALWR URD requirements without any special design features and unnecessary costs.

29611 (NUREG/CP–0142-Vol.1, pp. 43-48) **AP600 design certification thermal hydraulics testing and analysis.** Hochreiter, L.E.; Piplica, E.J. Nuclear Regulatory Commission, Washington, DC (United States). Div. of Systems Technology; American Nuclear Society, La Grange Park, IL (United States); American Inst. of Chemical Engineers, New York, NY (United States); American Society of Mechanical Engineers, New York, NY (United States); Canadian Nuclear Society, Toronto, ON (Canada); Japan Society of Multiphase Flow, Kyoto (Japan). Sep 1995. (CONF-950904–Vol.1: 7. international meeting on nuclear reactor thermal hydraulics, Saratoga, NY (United States), 10-15 Sep 1995). In *Proceedings of the 7th International Meeting on Nuclear Reactor Thermal-Hydraulics NURETH-7. Volume 1, Sessions 1-5.* 862p. Source: OSTI; NTIS; INIS; GPO.

Westinghouse Electric Corporation, in conjunction with the Department of Energy and the Electric Power Research Institute, have been developing an advanced light water reactor design; the AP600. The AP600 is a 1940 Mwt, 600Mwe unit which is similar to a Westinghouse two-loop Pressurized Water Reactor. The accumulated knowledge on reactor design to reduce the capital costs, construction time, and the operational and maintenance cost of the unit once it begins to generate electrical power. The AP600 design goal is to maintain an overall cost advantage over fossil generated electrical power.

29612 (NUREG/CP–0142-Vol.1, pp. 76-92) **A mechanistic determination of horizontal flow regime bound using void wave celerity.** Park, J.W. (Ajou Univ., Suwon (Korea, Republic of)). Nuclear Regulatory Commission, Washington, DC (United States). Div. of Systems Technology; American Nuclear Society, La Grange Park, IL (United States); American Inst. of Chemical Engineers, New York, NY (United States); American Society of Mechanical Engineers, New York, NY (United States); Canadian Nuclear Society, Toronto, ON (Canada); Japan Society of Multiphase Flow, Kyoto (Japan). Sep 1995. (CONF-950904–Vol.1: 7. international meeting on nuclear reactor thermal hydraulics, Saratoga, NY (United States), 10-15 Sep 1995). In *Proceedings of the 7th International Meeting on Nuclear Reactor Thermal-Hydraulics NURETH-7. Volume 1, Sessions 1-5.* 862p. Source: OSTI; NTIS; INIS; GPO.

The two-phase flow regime boundaries in a horizontal channel has been investigated by using the behavior of the second order void wave celerities. The average two-fluid model has been constituted with closure relations for horizontally stratified and bubbly flows. A vapor phase turbulent stress model for a smooth interface geometry has been included. It is found that the second order waves (i.e., eigenvalues) propagate in opposite direction with almost the same speed when the liquid phase is stationary. Using the well-posedness limit of the two-phase system, the dispersed-stratified flow regime boundary has been modeled. Two-phase Froude number has been theoretically found to be a convenient parameter in quantifying the flow regime boundary as a function of the void fraction. It is found that interaction between void wave celerities become stronger as the two-phase Froude number is reduced. This result should be interpreted as that gravity and the relative velocity are key parameters in determining flow regime boundaries in a horizontal flow. The influence of the vapor phase turbulent stress found to stabilize the flow stratification. This study clearly shows that the average two-fluid model is very effective for a mechanistic determination of horizontal flow regimes if appropriate closure relations are developed.

29613 (NUREG/CP–0142-Vol.1, pp. 93-110) **A criterion for the onset of slugging in horizontal stratified air-water countercurrent flow.** Chun, Moon-Hyun (Korea Advanced Institute of Science and Technology, Taejon (Korea, Republic of)); Lee, Byung-Ryung; Kim, Yang-Seok. Nuclear Regulatory Commission, Washington, DC (United States). Div. of Systems Technology;

American Nuclear Society, La Grange Park, IL (United States); American Inst. of Chemical Engineers, New York, NY (United States); American Society of Mechanical Engineers, New York, NY (United States); Canadian Nuclear Society, Toronto, ON (Canada); Japan Society of Multiphase Flow, Kyoto (Japan). Sep 1995. (CONF-950904–Vol.1: 7. international meeting on nuclear reactor thermal hydraulics, Saratoga, NY (United States), 10-15 Sep 1995). In *Proceedings of the 7th International Meeting on Nuclear Reactor Thermal-Hydraulics NURETH-7. Volume 1, Sessions 1-5.* 862p. Source: OSTI; NTIS; INIS; GPO.

This paper presents an experimental and theoretical investigation of wave height and transition criterion from wavy to slug flow in horizontal air-water countercurrent stratified flow conditions. A theoretical formula for the wave height in a stratified wavy flow regime has been developed using the concept of total energy balance over a wave crest to consider the shear stress acting on the interface of two fluids. From the limiting condition of the formula for the wave height, a necessary criterion for transition from a stratified wavy flow to a slug flow has been derived. A series of experiments have been conducted changing the non-dimensional water depth and the flow rates of air in a horizontal pipe and a duct. Comparisons between the measured data and the predictions of the present theory show that the agreement is within ±8%.

29614 (NUREG/CP–0142-Vol.1, pp. 131-140) **Local pressure gradients due to incipience of boiling in subcooled flows.** Ruggles, A.E. (Univ. of Tennessee, Knoxville, TN (United States)); McDuffee, J.L. Nuclear Regulatory Commission, Washington, DC (United States). Div. of Systems Technology; American Nuclear Society, La Grange Park, IL (United States); American Inst. of Chemical Engineers, New York, NY (United States); American Society of Mechanical Engineers, New York, NY (United States); Canadian Nuclear Society, Toronto, ON (Canada); Japan Society of Multiphase Flow, Kyoto (Japan). Sep 1995. (CONF-950904–Vol.1: 7. international meeting on nuclear reactor thermal hydraulics, Saratoga, NY (United States), 10-15 Sep 1995). In *Proceedings of the 7th International Meeting on Nuclear Reactor Thermal-Hydraulics NURETH-7. Volume 1, Sessions 1-5.* 862p. Source: OSTI; NTIS; INIS; GPO.

Models for vapor bubble behavior and nucleation site density during subcooled boiling are integrated with boundary layer theory in order to predict the local pressure gradient and heat transfer coefficient. Models for bubble growth rate and bubble departure diameter are used to scale the movement of displaced liquid in the laminar sublayer. An added shear stress, analogous to a turbulent shear stress, is derived by considering the liquid movement normal to the heated surface. The resulting mechanistic model has plausible functional dependence on wall superheat, mass flow, and heat flux and agrees well with data available in the literature.

29615 (NUREG/CP–0142-Vol.1, pp. 141-165) **Drift flux model as approximation of two fluid model for two phase dispersed and slug flow in tube.** Nigmatulin, R.I. Nuclear Regulatory Commission, Washington, DC (United States). Div. of Systems Technology; American Nuclear Society, La Grange Park, IL (United States); American Inst. of Chemical Engineers, New York, NY (United States); American Society of Mechanical Engineers, New York, NY (United States); Canadian Nuclear Society, Toronto, ON (Canada); Japan Society of Multiphase Flow, Kyoto (Japan). Sep 1995. (CONF-950904–Vol.1: 7. international meeting on nuclear reactor thermal hydraulics, Saratoga, NY (United States), 10-15 Sep 1995). In *Proceedings of the 7th International Meeting on Nuclear Reactor Thermal-Hydraulics NURETH-7. Volume 1, Sessions 1-5.* 862p. Source: OSTI; NTIS; INIS; GPO.

The analysis of one-dimensional schematizing for non-steady two-phase dispersed and slug flow in tube is presented. Quasi-static approximation, when inertia forces because of the accelerations of the phases may be neglected, is considered. Gas-liquid bubbly and slug vertical upward flows are analyzed. Non-trivial theoretical equations for slip velocity for these flows are derived. Juxtaposition of the derived equations for slip velocity with the famous Zuber-Findlay correlation as cross correlation coefficients is criticized. The generalization of non-steady drift flux Wallis theory taking into account influence of wall friction on the bubbly or slug flows for kinematical waves is considered.

29616 (NUREG/CP–0142-Vol.1, pp. 166-191) **Development, implementation and assessment of specific, two-fluid closure laws for inverted-annular film-boiling.** Cachard, F. de (Laboratory for Thermal Hydraulics, Villigen (Switzerland)). Nuclear Regulatory Commission, Washington, DC (United States). Div. of Systems Technology; American Nuclear Society, La Grange Park, IL (United States); American Inst. of Chemical Engineers, New York, NY (United States); American Society of Mechanical Engineers, New York, NY (United States); Canadian Nuclear Society, Toronto, ON (Canada); Japan Society of Multiphase Flow, Kyoto (Japan). Sep 1995. (CONF-950904–Vol.1: 7. international meeting on nuclear reactor thermal hydraulics, Saratoga, NY (United States), 10-15 Sep 1995). In *Proceedings of the 7th International Meeting on Nuclear Reactor Thermal-Hydraulics NURETH-7. Volume 1, Sessions 1-5.* 862p. Source: OSTI; NTIS; INIS; GPO.

Inverted-Annular Film-Boiling (IAFB) is one of the post-burnout heat transfer modes taking place during the reflooding phase of the loss-of-coolant accident, when the liquid at the quench front is subcooled. Under IAFB conditions, a continuous, liquid core is separated from the wall by a superheated vapour film. the heat transfer rate in IAFB is influenced by the flooding rate, liquid subcooling, pressure, and the wall geometry and temperature. These influences can be accounted by a two-fluid model with physically sound closure laws for mass, momentum and heat transfers between the wall, the vapour film, the vapour-liquid interface, and the liquid core. Such closure laws have been developed and adjusted using IAFB-relevant experimental results, including heat flux, wall temperature and void fraction data. The model is extensively assessed against data from three independent sources. A total of 46 experiments have been analyzed. The overall predictions are good. The IAFB-specific closure laws proposed have also intrinsic value, and may be used in other two-fluid models. They should allow to improve the description of post-dryout, low quality heat transfer by the safety codes.

29617 (NUREG/CP–0142-Vol.1, pp. 192-211) **Analytical solution of laminar-laminar stratified two-phase flows with curved interfaces.** Brauner, N. (Tel-Aviv Univ. (Israel)); Rovinsky, J.; Maron, D.M. Nuclear Regulatory Commission, Washington, DC (United States). Div. of Systems Technology; American Nuclear Society, La Grange Park, IL (United States); American Inst. of Chemical Engineers, New York, NY (United States); American Society of Mechanical Engineers, New York, NY (United States); Canadian Nuclear Society, Toronto, ON (Canada); Japan Society of Multiphase Flow, Kyoto (Japan). Sep 1995. (CONF-950904–Vol.1: 7. international meeting on nuclear reactor thermal hydraulics, Saratoga, NY (United States), 10-15 Sep 1995). In *Proceedings of the 7th International Meeting on Nuclear Reactor Thermal-Hydraulics NURETH-7. Volume 1, Sessions 1-5.* 862p. Source: OSTI; NTIS; INIS; GPO.

The present study represents a complete analytical solution for laminar two-phase flows with curved interfaces. The solution of the Navier-Stokes equations for the two-phases in bipolar coordinates provides the 'flow monograms' describe the relation between the interface curvature and the insitu flow geometry when given the phases flow rates and viscosity ratios. Energy considerations are employed to construct the 'interface monograms', whereby the characteristic interfacial curvature is determined in terms of the phases insitu holdup, pipe diameter, surface tension, fluids/wall adhesion and gravitation. The two monograms are then combined to construct the system 'operational monogram'. The 'operational monogram' enables the determination of the interface configuration, the local flow characteristics, such as velocity profiles, wall and interfacial shear stresses distribution as well as the integral characteristics of the two-phase flow: phases insitu holdup and pressure drop.

29618 (NUREG/CP–0142-Vol.1, pp. 212-230) **Velocity of large bubble in liquid-solid mixture in a vertical tube.** Hamaguchi, H. (Kobe Univ., Kobe (Japan)); Sakaguchi, T. Nuclear Regulatory Commission, Washington, DC (United States). Div. of Systems Technology; American Nuclear Society, La Grange Park, IL (United States); American Inst. of Chemical Engineers, New York, NY (United States); American Society of Mechanical Engineers, New York, NY (United States); Canadian Nuclear Society,

Toronto, ON (Canada); Japan Society of Multiphase Flow, Kyoto (Japan). Sep 1995. (CONF-950904–Vol.1: 7. international meeting on nuclear reactor thermal hydraulics, Saratoga, NY (United States), 10-15 Sep 1995). In *Proceedings of the 7th International Meeting on Nuclear Reactor Thermal-Hydraulics NURETH-7. Volume 1, Sessions 1-5.* 862p. Source: OSTI; NTIS; INIS; GPO.

The upward movement of a large bubble in a stationary mixture of liquid and solid is one of the most fundamental phenomena of gas-liquid-solid three phase slug flow in a vertical tube. The purpose of this study is to make clear the characteristic of the rising velocity of this fundamental flow experimentally. The rising velocity of a large bubble V in a liquid-solid mixture was measured and compared with the velocity V_o in a liquid (without solid). The experimental results were correlated using a non-dimensional velocity $V^*(=V/V_o)$, and the following results were obtained. It was found that the characteristic of the rising velocity differs according to the tube diameter and the liquid viscosity, or the Galileo number in the non-dimensional expression. It can be classified into two regimes. (i) When the liquid viscosity is large (or the tube diameter is small), V^* decreases linearly against the volumetric solid fraction ϵ of the mixture. (ii) When the viscosity is small, on the other hand, the relation between V^* and ϵ is not linear. This classification can be explained by the results in the previous papers by the authors dealing with a large bubble in a liquid.

29619 (NUREG/CP–0142-Vol.1, pp. 231-247) **About the statistical description of gas-liquid flows.** Sanz, D. (Centro Atomico Bariloche and Instituto Balseiro (Argentina)); Guido-Lavalle, G.; Carrica, P. Nuclear Regulatory Commission, Washington, DC (United States). Div. of Systems Technology; American Nuclear Society, La Grange Park, IL (United States); American Inst. of Chemical Engineers, New York, NY (United States); American Society of Mechanical Engineers, New York, NY (United States); Canadian Nuclear Society, Toronto, ON (Canada); Japan Society of Multiphase Flow, Kyoto (Japan). Sep 1995. (CONF-950904–Vol.1: 7. international meeting on nuclear reactor thermal hydraulics, Saratoga, NY (United States), 10-15 Sep 1995). In *Proceedings of the 7th International Meeting on Nuclear Reactor Thermal-Hydraulics NURETH-7. Volume 1, Sessions 1-5.* 862p. Source: OSTI; NTIS; INIS; GPO.

Elements of the probabilistic geometry are used to derive the bubble coalescence term of the statistical description of gas liquid flows. It is shown that the Boltzmann's hypothesis, that leads to the kinetic theory of dilute gases, is not appropriate for this kind of flows. The resulting integro-differential transport equation is numerically integrated to study the flow development in slender bubble columns. The solution remarkably predicts the transition from bubbly to slug flow pattern. Moreover, a bubbly bimodal size distribution is predicted, which has already been observed experimentally.

29620 (NUREG/CP–0142-Vol.1, pp. 248-262) **Entropy analysis on non-equilibrium two-phase flow models.** Karwat, H. (Technische Universitaet Muenchen, Garching (Germany)); Ruan, Y.Q. Nuclear Regulatory Commission, Washington, DC (United States). Div. of Systems Technology; American Nuclear Society, La Grange Park, IL (United States); American Inst. of Chemical Engineers, New York, NY (United States); American Society of Mechanical Engineers, New York, NY (United States); Canadian Nuclear Society, Toronto, ON (Canada); Japan Society of Multiphase Flow, Kyoto (Japan). Sep 1995. (CONF-950904–Vol.1: 7. international meeting on nuclear reactor thermal hydraulics, Saratoga, NY (United States), 10-15 Sep 1995). In *Proceedings of the 7th International Meeting on Nuclear Reactor Thermal-Hydraulics NURETH-7. Volume 1, Sessions 1-5.* 862p. Source: OSTI; NTIS; INIS; GPO.

A method of entropy analysis according to the second law of thermodynamics is proposed for the assessment of a class of practical non-equilibrium two-phase flow models. Entropy conditions are derived directly from a local instantaneous formulation for an arbitrary control volume of a structural two-phase fluid, which are finally expressed in terms of the averaged thermodynamic independent variables and their time derivatives as well as the boundary conditions for the volume. On the basis of a widely used thermal-hydraulic system code it is demonstrated with practical examples that entropy production rates in control volumes can be numerically quantified by using the data from the output data files. Entropy analysis using the proposed method is useful in identifying some potential problems in two-phase flow models and predictions as well as in studying the effects of some free parameters in closure relationships.

29621 (NUREG/CP–0142-Vol.1, pp. 264-283) **A general unified non-equilibrium model for predicting saturated and subcooled critical two-phase flow rates through short and long tubes.** Fraser, D.W.H. (Univ. of British Columbia (Canada)); Abdelmessih, A.H. Nuclear Regulatory Commission, Washington, DC (United States). Div. of Systems Technology; American Nuclear Society, La Grange Park, IL (United States); American Inst. of Chemical Engineers, New York, NY (United States); American Society of Mechanical Engineers, New York, NY (United States); Canadian Nuclear Society, Toronto, ON (Canada); Japan Society of Multiphase Flow, Kyoto (Japan). Sep 1995. Grant OGP-0004172. (CONF-950904–Vol.1: 7. international meeting on nuclear reactor thermal hydraulics, Saratoga, NY (United States), 10-15 Sep 1995). In *Proceedings of the 7th International Meeting on Nuclear Reactor Thermal-Hydraulics NURETH-7. Volume 1, Sessions 1-5.* 862p. Source: OSTI; NTIS; INIS; GPO.

A general unified model is developed to predict one-component critical two-phase pipe flow. Modelling of the two-phase flow is accomplished by describing the evolution of the flow between the location of flashing inception and the exit (critical) plane. The model approximates the nonequilibrium phase change process via thermodynamic equilibrium paths. Included are the relative effects of varying the location of flashing inception, pipe geometry, fluid properties and length to diameter ratio. The model predicts that a range of critical mass fluxes exist and is bound by a maximum and minimum value for a given thermodynamic state. This range is more pronounced at lower subcooled stagnation states and can be attributed to the variation in the location of flashing inception. The model is based on the results of an experimental study of the critical two-phase flow of saturated and subcooled water through long tubes. In that study, the location of flashing inception was accurately controlled and adjusted through the use of a new device. The data obtained revealed that for fixed stagnation conditions, the maximum critical mass flux occurred with flashing inception located near the pipe exit; while minimum critical mass fluxes occurred with the flashing front located further upstream. Available data since 1970 for both short and long tubes over a wide range of conditions are compared with the model predictions. This includes test section L/D ratios from 25 to 300 and covers a temperature and pressure range of 110 to 280°C and 0.16 to 6.9 MPa. respectively. The predicted maximum and minimum critical mass fluxes show an excellent agreement with the range observed in the experimental data.

29622 (NUREG/CP–0142-Vol.1, pp. 284-298) **Predictions of bubbly flows in vertical pipes using two-fluid models in CFDS-FLOW3D code.** Banas, A.O. (Chalk River Laboratories (Canada)); Carver, M.B.; Unrau, D. Nuclear Regulatory Commission, Washington, DC (United States). Div. of Systems Technology; American Nuclear Society, La Grange Park, IL (United States); American Inst. of Chemical Engineers, New York, NY (United States); American Society of Mechanical Engineers, New York, NY (United States); Canadian Nuclear Society, Toronto, ON (Canada); Japan Society of Multiphase Flow, Kyoto (Japan). Sep 1995. (CONF-950904–Vol.1: 7. international meeting on nuclear reactor thermal hydraulics, Saratoga, NY (United States), 10-15 Sep 1995). In *Proceedings of the 7th International Meeting on Nuclear Reactor Thermal-Hydraulics NURETH-7. Volume 1, Sessions 1-5.* 862p. Source: OSTI; NTIS; INIS; GPO.

This paper reports the results of a preliminary study exploring the performance of two sets of two-fluid closure relationships applied to the simulation of turbulent air-water bubbly upflows through vertical pipes. Predictions obtained with the default CFDS-FLOW3D model for dispersed flows were compared with the predictions of a new model (based on the work of Lee), and with the experimental data of Liu. The new model, implemented in the CFDS-FLOW3D code, included additional source terms in the "standard" κ-ϵ transport equations for the liquid phase, as well as modified model coefficients and wall functions. All simulations were

carried out in a 2-D axisymmetric format, collapsing the general multifluid framework of CFDS-FLOW3D to the two-fluid (air-water) case. The newly implemented model consistently improved predictions of radial-velocity profiles of both phases, but failed to accurately reproduce the experimental phase-distribution data. This shortcoming was traced to the neglect of anisotropic effects in the modelling of liquid-phase turbulence. In this sense, the present investigation should be considered as the first step toward the ultimate goal of developing a theoretically sound and universal CFD-type two-fluid model for bubbly flows in channels.

29623 (NUREG/CP–0142-Vol.1, pp. 299-311) **Condensation during gravity driven ECC: Experiments with PACTEL.** Munther, R. (Lappeenranta Univ. of Technology (Finland)); Kalli, H.; Kouhia, J. Nuclear Regulatory Commission, Washington, DC (United States). Div. of Systems Technology; American Nuclear Society, La Grange Park, IL (United States); American Inst. of Chemical Engineers, New York, NY (United States); American Society of Mechanical Engineers, New York, NY (United States); Canadian Nuclear Society, Toronto, ON (Canada); Japan Society of Multiphase Flow, Kyoto (Japan). Sep 1995. (CONF-950904–Vol.1: 7. international meeting on nuclear reactor thermal hydraulics, Saratoga, NY (United States), 10-15 Sep 1995). In *Proceedings of the 7th International Meeting on Nuclear Reactor Thermal-Hydraulics NURETH-7. Volume 1, Sessions 1-5.* 862p. Source: OSTI; NTIS; INIS; GPO.

This paper provides the results of the second series of gravity driven emergency core cooling (ECC) experiments with PACTEL (Parallel Channel Test Loop). The simulated accident was a small break loss-of-coolant accident (SBLOCA) with a break in a cold leg. The ECC flow was provided from a core makeup tank (CMT) located at a higher elevation than the main part of the primary system. The CMT was pressurized with pipings from the pressurizer and a cold leg. The tests indicated that steam condensation in the CMT can prevent ECC and lead to core uncovery.

29624 (NUREG/CP–0142-Vol.1, pp. 312-335) **An investigation of condensation from steam-gas mixtures flowing downward inside a vertical tube.** Kuhn, S.Z. (Univ. of California, Berkeley, CA (United States)); Schrock, V.E.; Peterson, P.F. Nuclear Regulatory Commission, Washington, DC (United States). Div. of Systems Technology; American Nuclear Society, La Grange Park, IL (United States); American Inst. of Chemical Engineers, New York, NY (United States); American Society of Mechanical Engineers, New York, NY (United States); Canadian Nuclear Society, Toronto, ON (Canada); Japan Society of Multiphase Flow, Kyoto (Japan). Sep 1995. (CONF-950904–Vol.1: 7. international meeting on nuclear reactor thermal hydraulics, Saratoga, NY (United States), 10-15 Sep 1995). In *Proceedings of the 7th International Meeting on Nuclear Reactor Thermal-Hydraulics NURETH-7. Volume 1, Sessions 1-5.* 862p. Source: OSTI; NTIS; INIS; GPO.

Previous experiments have been carried out by Vierow, Ogg, Kageyama and Siddique for condensation from steam/gas mixtures in vertical tubes. In each case the data scatter relative to the correlation was large and there was not close agreement among the three investigations. A new apparatus has been designed and built using the lessons learned from the earlier studies. Using the new apparatus, an extensive new data base has been obtained for pure steam, steam-air mixtures and steam-helium mixtures. Three different correlations, one implementing the degradation method initially proposed by Vierow and Schrock, a second diffusion layer theory initially proposed by Peterson, and third mass transfer conductance model are presented in this paper. The correlation using the simple degradation factor method has been shown, with some modification, to give satisfactory engineering accuracy when applied to the new data. However, this method is based on very simplified arguments that do not fully represent the complex physical phenomena involved. Better representation of the data has been found possible using modifications of the more complex and phenomenologically based method which treats the heat transfer conductance of the liquid film in series with the conductance on the vapor-gas side with the latter comprised of mass transfer and sensible heat transfer conductance acting in parallel. The mechanistic models, based on the modified diffusion layer theory or classical mass transfer theory for mass transfer conductance with transpiration successfully correlate the data for the heat transfer of vapor-gas side. Combined with the heat transfer of liquid film model proposed by Blangetti, the overall heat transfer coefficients predicted by the correlations from mechanistic models are in close agreement with experimental values.

29625 (NUREG/CP–0142-Vol.1, pp. 336-352) **Study of condensation heat transfer following a main steam line break inside containment.** Cho, J.H. (Stone & Webster Engineering Corporation, Boston, MA (United States)); Elia, F.A. Jr.; Lischer, D.J. Nuclear Regulatory Commission, Washington, DC (United States). Div. of Systems Technology; American Nuclear Society, La Grange Park, IL (United States); American Inst. of Chemical Engineers, New York, NY (United States); American Society of Mechanical Engineers, New York, NY (United States); Canadian Nuclear Society, Toronto, ON (Canada); Japan Society of Multiphase Flow, Kyoto (Japan). Sep 1995. (CONF-950904–Vol.1: 7. international meeting on nuclear reactor thermal hydraulics, Saratoga, NY (United States), 10-15 Sep 1995). In *Proceedings of the 7th International Meeting on Nuclear Reactor Thermal-Hydraulics NURETH-7. Volume 1, Sessions 1-5.* 862p. Source: OSTI; NTIS; INIS; GPO.

An alternative model for calculating condensation heat transfer following a main stream line break (MSLB) accident is proposed. The proposed model predictions and the current regulatory model predictions are compared to the results of the Carolinas Virginia Tube Reactor (CVTR) test. The very conservative results predicted by the current regulatory model result from: (1) low estimate of the condensation heat transfer coefficient by the Uchida correlation and (2) neglecting the convective contribution to the overall heat transfer. Neglecting the convection overestimates the mass of steam being condensed and does not permit the calculation of additional convective heat transfer resulting from superheated conditions. In this study, the Uchida correlation is used, but correction factors for the effects of convection an superheat are derived. The proposed model uses heat and mass transfer analogy methods to estimate to convective fraction of the total heat transfer and bases the steam removal rate on the condensation heat transfer portion only. The results predicted by the proposed model are shown to be conservative and more accurate than those predicted by the current regulatory model when compared with the results of the CVTR test. Results for typical pressurized water reactors indicate that the proposed model provides a basis for lowering the equipment qualification temperature envelope, particularly at later times following the accident.

29626 (NUREG/CP–0142-Vol.1, pp. 353-376) **Effect of subcooling and wall thickness on pool boiling from downward-facing curved surfaces in water.** El-Genk, M.S. (Univ. of New Mexico, Albuquerque, NM (United States)); Glebov, A.G. Nuclear Regulatory Commission, Washington, DC (United States). Div. of Systems Technology; American Nuclear Society, La Grange Park, IL (United States); American Inst. of Chemical Engineers, New York, NY (United States); American Society of Mechanical Engineers, New York, NY (United States); Canadian Nuclear Society, Toronto, ON (Canada); Japan Society of Multiphase Flow, Kyoto (Japan). Sep 1995. (CONF-950904–Vol.1: 7. international meeting on nuclear reactor thermal hydraulics, Saratoga, NY (United States), 10-15 Sep 1995). In *Proceedings of the 7th International Meeting on Nuclear Reactor Thermal-Hydraulics NURETH-7. Volume 1, Sessions 1-5.* 862p. Source: OSTI; NTIS; INIS; GPO.

Quenching experiments were performed to investigate the effects of water subcooling and wall thickness on pool boiling from a downward-facing curved surface. Experiments used three copper sections of the same diameter (50.8 mm) and surface radius (148 mm), but different thickness (12.8, 20 and 30 mm). Local and average pool boiling curves were obtained at saturation and 5 K, 10 K, and 14 K subcooling. Water subcooling increased the maximum heat flux, but decreased the corresponding wall superheat. The minimum film boiling heat flux and the corresponding wall superheat, however, increased with increased subcooling. The maximum and minimum film boiling heat fluxes were independent of wall thickness above 20 mm and Biot Number > 0.8, indicating that boiling curves for the 20 and 30 thick sections were representative of quasi steady-state, but not those for the 12.8 mm thick section.

When compared with that for a flat surface section of the same thickness, the data for the 12.8 mm thick section showed significant increases in both the maximum heat flux (from 0.21 to 0.41 MW/m^2) and the minimum film boiling heat flux (from 2 to 13 kW/m^2) and about 11.5 K and 60 K increase in the corresponding wall superheats, respectively.

29627 (NUREG/CP–0142-Vol.1, pp. 377-401) **Numerical modeling of condensation from vapor-gas mixtures for forced down flow inside a tube.** Yuann, R.Y. (Taiwan Power Company, Taipei (Taiwan, Province of China)); Schrock, V.E.; Chen, Xiang, M. Nuclear Regulatory Commission, Washington, DC (United States). Div. of Systems Technology; American Nuclear Society, La Grange Park, IL (United States); American Inst. of Chemical Engineers, New York, NY (United States); American Society of Mechanical Engineers, New York, NY (United States); Canadian Nuclear Society, Toronto, ON (Canada); Japan Society of Multiphase Flow, Kyoto (Japan). Sep 1995. (CONF-950904–Vol.1: 7. international meeting on nuclear reactor thermal hydraulics, Saratoga, NY (United States), 10-15 Sep 1995). In *Proceedings of the 7th International Meeting on Nuclear Reactor Thermal-Hydraulics NURETH-7. Volume 1, Sessions 1-5.* 862p. Source: OSTI; NTIS; INIS; GPO.

Laminar film condensation is the dominant heat transfer mode inside tubes. In the present paper direct numerical simulation of the detailed transport process within the steam-gas core flow and in the condensate film is carried out. The problem was posed as an axisymmetric two dimensional (r, z) gas phase inside an annular condensate film flow with an assumed smooth interface. The fundamental conservation equations were written for mass, momentum, species concentration and energy in the gaseous phase with effective diffusion parameters characterizing the turbulent region. The low Reynolds number two equation κ-ϵ model was employed to determine the eddy diffusion coefficients. The liquid film was described by similar formulation without the gas species equation. An empirical correlation was employed to correct for the effect of film waviness on the interfacial shear. A computer code named COAPIT (Condensation Analysis Program Inside Tube) was developed to implement numerical solution of the fundamental equations. The equations were solved by a marching technique working downstream from the entrance of the condensing section. COAPIT was benchmarked against experimental data and overall reasonable agreement was found for the key parameters such as heat transfer coefficient and tube inner wall temperature. The predicted axial development of radial profiles of velocity, composition and temperature and occurrence of metastable vapor add insight to the physical phenomena.

29628 (NUREG/CP–0142-Vol.1, pp. 402-422) **A model for the performance of a vertical tube condenser in the presence of noncondensable gases.** Guentay, A.D.S. Nuclear Regulatory Commission, Washington, DC (United States). Div. of Systems Technology; American Nuclear Society, La Grange Park, IL (United States); American Inst. of Chemical Engineers, New York, NY (United States); American Society of Mechanical Engineers, New York, NY (United States); Canadian Nuclear Society, Toronto, ON (Canada); Japan Society of Multiphase Flow, Kyoto (Japan). Sep 1995. (CONF-950904–Vol.1: 7. international meeting on nuclear reactor thermal hydraulics, Saratoga, NY (United States), 10-15 Sep 1995). In *Proceedings of the 7th International Meeting on Nuclear Reactor Thermal-Hydraulics NURETH-7. Volume 1, Sessions 1-5.* 862p. Source: OSTI; NTIS; INIS; GPO.

Some proposed vertical tube condensers are designed to operate at high noncondensable fractions, which warrants a simple model to predict their performance. Models developed thus far are usually non self-contained as they require the specification of the wall temperature to predict the local condensation rate. The present model attempts to fill this gap by addressing the secondary side heat transfer as well. Starting with momentum balance which includes the effect of interfacial shear stress, a Nusselt-type algebraic equation is derived for the film thickness as a function of flow and geometry parameters. The heat and mass transfer analogy relations are then invoked to deduce the condensation rate of steam onto the tube wall. Lastly, the heat transfer to the secondary side is modelled to include cooling by forced, free or mixed convection flows. The model is used for parametric simulations to determine the impact on the condenser performance of important factors such as the inlet gas fraction, the mixture inlet flowrate, the total pressure, and the molecular weight of the noncondensable gas. The model performed simulations of some experiments with pure steam and air-steam mixtures flowing down a vertical tube. The model predicts the data quite well.

29629 (NUREG/CP–0142-Vol.1, pp. 423-433) **UPTF-TRAM experiments for SBLOCA: Evaluation of condensation processes in TRAM tests A6 and A7.** Sonneburg, H.G. (Gesellschaft fuer Anlagen-und Reaktorsicherheit (GRS), Muenchen (Germany)); Tuunanen, J.; Palazov, V.V. Nuclear Regulatory Commission, Washington, DC (United States). Div. of Systems Technology; American Nuclear Society, La Grange Park, IL (United States); American Inst. of Chemical Engineers, New York, NY (United States); American Society of Mechanical Engineers, New York, NY (United States); Canadian Nuclear Society, Toronto, ON (Canada); Japan Society of Multiphase Flow, Kyoto (Japan). Sep 1995. Project RS 878. (CONF-950904–Vol.1: 7. international meeting on nuclear reactor thermal hydraulics, Saratoga, NY (United States), 10-15 Sep 1995). In *Proceedings of the 7th International Meeting on Nuclear Reactor Thermal-Hydraulics NURETH-7. Volume 1, Sessions 1-5.* 862p. Source: OSTI; NTIS; INIS; GPO.

The investigation of thermal-hydraulic phenomena related to reactor transients with accident management measures is the goal of the TRansient and accident Management (TRAM) experimental programme being carried out at the Upper Plenum Test Facility (UPTF) at Mannheim (Germany). These experimental investigations and test analyses are funded by the German Federal Minister for Research and Technology (BMFT). The UPTF simulates these phenomena in a 1:1 such relative to the dimension of a PWR. Condensation of steam during Emergency Core Cooling (ECC) water injection from accumulators into the primary system is one of the phenomena studied within the accumulators into the primary system is one of the phenomena studied within the TRAM programme. This phenomenon partly controls the efficiency of accumulator injection if the high pressure safety systems fail. Beside this, the condensation within the nitrogen inside the accumulator for a certain period controls the pressure development inside the accumulator. Thus, both condensation phenomena determine the ECC flow rate delivered to the primary system. Concerning the condensation inside the primary system, this is also of safety relevance in the case of Pressurized Thermal Shock (PTS) during cold leg injection.

29630 (NUREG/CP–0142-Vol.1, pp. 434-460) **Condensation heat transfer coefficient with noncondensible gases for heat transfer in thermal hydraulic codes.** Banerjee, S. (Texas A&M Univ., College Station, TX (United States)); Hassan, Y.A. Nuclear Regulatory Commission, Washington, DC (United States). Div. of Systems Technology; American Nuclear Society, La Grange Park, IL (United States); American Inst. of Chemical Engineers, New York, NY (United States); American Society of Mechanical Engineers, New York, NY (United States); Canadian Nuclear Society, Toronto, ON (Canada); Japan Society of Multiphase Flow, Kyoto (Japan). Sep 1995. (CONF-950904–Vol.1: 7. international meeting on nuclear reactor thermal hydraulics, Saratoga, NY (United States), 10-15 Sep 1995). In *Proceedings of the 7th International Meeting on Nuclear Reactor Thermal-Hydraulics NURETH-7. Volume 1, Sessions 1-5.* 862p. Source: OSTI; NTIS; INIS; GPO.

Condensation in the presence of noncondensible gases plays an important role in the nuclear industry. The RELAP5/MOD3 thermal hydraulic code was used to study the ability of the code to predict this phenomenon. Two separate effects experiments were simulated using this code. These were the Massachusetts Institute of Technology's (MIT) Pressurizer Experiment, the MIT Single Tube Experiment. A new iterative approach to calculate the interface temperature and the degraded heat transfer coefficient was developed and implemented in the RELAP5/MOD3 thermal hydraulic code. This model employs the heat transfer simultaneously. This model was found to perform much better than the reduction factor approach. The calculations using the new model were found to be in much better agreement with the experimental values.

29631 (NUREG/CP–0142-Vol.1, pp. 462-477) **Experimental study of horizontal annular channels under non-developed**

conditions. Delgadino, G. (Rensselaer Polytechnic Institute, Troy, NY (United States)); Balino, J.; Carrica, P. Nuclear Regulatory Commission, Washington, DC (United States). Div. of Systems Technology; American Nuclear Society, La Grange Park, IL (United States); American Inst. of Chemical Engineers, New York, NY (United States); American Society of Mechanical Engineers, New York, NY (United States); Canadian Nuclear Society, Toronto, ON (Canada); Japan Society of Multiphase Flow, Kyoto (Japan). Sep 1995. (CONF-950904--Vol.1: 7. international meeting on nuclear reactor thermal hydraulics, Saratoga, NY (United States), 10-15 Sep 1995). In *Proceedings of the 7th International Meeting on Nuclear Reactor Thermal-Hydraulics NURETH-7. Volume 1, Sessions 1-5.* 862p. Source: OSTI; NTIS; INIS; GPO.

In this work an experimental study of the two-phase air-water flow in a horizontal annular channel under non-developed conditions is presented. A conductive local probe was placed at the end of the channel to measure the local phase indication function under a wide range of gas and water flow rates. The signal was processed to obtain the void fraction and statistical distributions of liquid and gas residence times. From these data the topology of the flow could be inferred. A laser intermittence detector was also located close to the channel exit, in order to measure statistical parameters for intermittent flows by means of a two-probe method.

29632 (NUREG/CP--0142-Vol.1, pp. 478-486) **Interfacial shear stress in stratified flow in a horizontal rectangular duct.** Lorencez, C. (Univ. of Toronto (Canada)); Kawaji, M.; Murao, Y. Nuclear Regulatory Commission, Washington, DC (United States). Div. of Systems Technology; American Nuclear Society, La Grange Park, IL (United States); American Inst. of Chemical Engineers, New York, NY (United States); American Society of Mechanical Engineers, New York, NY (United States); Canadian Nuclear Society, Toronto, ON (Canada); Japan Society of Multiphase Flow, Kyoto (Japan). Sep 1995. (CONF-950904--Vol.1: 7. international meeting on nuclear reactor thermal hydraulics, Saratoga, NY (United States), 10-15 Sep 1995). In *Proceedings of the 7th International Meeting on Nuclear Reactor Thermal-Hydraulics NURETH-7. Volume 1, Sessions 1-5.* 862p. Source: OSTI; NTIS; INIS; GPO.

Interfacial shear stress has been experimentally examined for both cocurrent and countercurrent stratified wavy flows in a horizontal interfacial shear stress from the measurements were examined and the results have been compared with existing correlations. Some differences were found in the estimated interfacial shear stress from the measurements were examined and the results have been compared with existing correlations. Some differences were found in the estimated interfacial shear stress values at high gas flow rates which could be attributed to the assumptions and procedures involved in each method. The interfacial waves and secondary motions were also found to have significant effects on the accuracy of Reynolds stress and turbulence kinetic energy extrapolation methods.

29633 (NUREG/CP--0142-Vol.1, pp. 487-496) **Quenching phenomena in natural circulation loop.** Umekawa, Hisashi (Kansai Univ., Osaka (Japan)); Ozawa, Mamoru; Ishida, Naoki. Nuclear Regulatory Commission, Washington, DC (United States). Div. of Systems Technology; American Nuclear Society, La Grange Park, IL (United States); American Inst. of Chemical Engineers, New York, NY (United States); American Society of Mechanical Engineers, New York, NY (United States); Canadian Nuclear Society, Toronto, ON (Canada); Japan Society of Multiphase Flow, Kyoto (Japan). Sep 1995. Grant 05750203. (CONF-950904--Vol.1: 7. international meeting on nuclear reactor thermal hydraulics, Saratoga, NY (United States), 10-15 Sep 1995). In *Proceedings of the 7th International Meeting on Nuclear Reactor Thermal-Hydraulics NURETH-7. Volume 1, Sessions 1-5.* 862p. Source: OSTI; NTIS; INIS; GPO.

Quenching phenomena has been investigated experimentally using circulation loop of liquid nitrogen. During the quenching under natural circulation, the heat transfer mode changes from film boiling to nucleate boiling, and at the same time flux changes with time depending on the vapor generation rate and related two-phase flow characteristics. Moreover, density wave oscillations occur under a certain operating condition, which is closely related to the dynamic behavior of the cooling curve. The experimental results indicates that the occurrence of the density wave oscillation induces the deterioration of effective cooling of the heat surface in the film and the transition boiling regions, which results in the decrease in the quenching velocity.

29634 (NUREG/CP--0142-Vol.1, pp. 497-507) **Measurement of the interaction between the flow and the free surface of a liquid.** Okamoto, Koji (Univ. of Tokyo, Ibaraki (Japan)); Schmidl, W.D.; Philip, O.G. Nuclear Regulatory Commission, Washington, DC (United States). Div. of Systems Technology; American Nuclear Society, La Grange Park, IL (United States); American Inst. of Chemical Engineers, New York, NY (United States); American Society of Mechanical Engineers, New York, NY (United States); Canadian Nuclear Society, Toronto, ON (Canada); Japan Society of Multiphase Flow, Kyoto (Japan). Sep 1995. (CONF-950904--Vol.1: 7. international meeting on nuclear reactor thermal hydraulics, Saratoga, NY (United States), 10-15 Sep 1995). In *Proceedings of the 7th International Meeting on Nuclear Reactor Thermal-Hydraulics NURETH-7. Volume 1, Sessions 1-5.* 862p. Source: OSTI; NTIS; INIS; GPO.

The interaction between the flow and free surface was evaluated measuring the velocity distribution and surface movement simultaneously. The test section was a rectangular tank having a free surface. A rectangular nozzle was set near the free surface, causing the wavy free surface condition. The flow under the free surface was visualized by a laser light sheet and small tracer particles. With image processing techniques, the movement of the free surface and the movement of the particles were simultaneously measured from the recorded images, resulting in the velocity distributions and surface locations. Then, the interactions between the flow and free surface were evaluated using the form of turbulent energy and surface-related turbulent values. By increasing the turbulent energy near the free surface, the fluctuations of the free surface height and the inclination of the free surface were increased. The higher fluctuation of horizontal velocity was related to the higher surface position and negative inclination. The image processing technique is found to be very useful to evaluate the interaction between free surface and flow.

29635 (NUREG/CP--0142-Vol.1, pp. 508-513) **The use of waveguide acoustic probes for void fraction measurement in the evaporator of BN-350-Type reactor.** Melnikov, V.I.; Nigmatulin, B.I. Nuclear Regulatory Commission, Washington, DC (United States). Div. of Systems Technology; American Nuclear Society, La Grange Park, IL (United States); American Inst. of Chemical Engineers, New York, NY (United States); American Society of Mechanical Engineers, New York, NY (United States); Canadian Nuclear Society, Toronto, ON (Canada); Japan Society of Multiphase Flow, Kyoto (Japan). Sep 1995. (CONF-950904--Vol.1: 7. international meeting on nuclear reactor thermal hydraulics, Saratoga, NY (United States), 10-15 Sep 1995). In *Proceedings of the 7th International Meeting on Nuclear Reactor Thermal-Hydraulics NURETH-7. Volume 1, Sessions 1-5.* 862p. Source: OSTI; NTIS; INIS; GPO.

The present paper deals with some results of the experimental studies which have been carried out to investigate the steam generation dynamics in the Field tubes of sodium-water evaporators used in the BN-350 reactors. The void fraction measurements have been taken with the aid of waveguide acoustic transducers manufactured in accordance with a specially designed technology (waveguide acoustic transducers-WAT technology). Presented in this paper also the transducer design and calibration methods, as well as the diagram showing transducers arrengment in the evaporator. The transducers under test featured a waveguide of about 4 m in length and a 200-mm long sensitive element (probe). Besides, this paper specifies the void fraction data obtained through measurements in diverse points of the evaporator. The studies revealed that the period of observed fluctuations in the void fraction amounted to few seconds and was largely dependent on the level of water in the evaporator.

29636 (NUREG/CP--0142-Vol.1, pp. 514-531) **Buoyancy-driven flow excursions in fuel assemblies.** Laurinat, J.E. (Westinghouse Savannah River Company, Aiken, SC (United States)); Paul, P.K.; Menna, J.D. Nuclear Regulatory Commission,

Washington, DC (United States). Div. of Systems Technology; American Nuclear Society, La Grange Park, IL (United States); American Inst. of Chemical Engineers, New York, NY (United States); American Society of Mechanical Engineers, New York, NY (United States); Canadian Nuclear Society, Toronto, ON (Canada); Japan Society of Multiphase Flow, Kyoto (Japan). Sep 1995. (CONF-950904–Vol.1: 7. international meeting on nuclear reactor thermal hydraulics, Saratoga, NY (United States), 10-15 Sep 1995). In *Proceedings of the 7th International Meeting on Nuclear Reactor Thermal-Hydraulics NURETH-7. Volume 1, Sessions 1-5.* 862p. Source: OSTI; NTIS; INIS; GPO.

A power limit criterion was developed for a postulated Loss of Pumping Accident (LOPA) in one of the recently shut down heavy water production reactors at the Savannah River Site. These reactors were cooled by recirculating heavy water moderator downward through channels in cylindrical fuel tubes. Powers were limited to safeguard against a flow excursion in one of more of these parallel channels. During-full-power operation, limits safeguarded against a boiling flow excursion. At low flow rates, during the addition of emergency cooling water, buoyant forces reverse the flow in one of the coolant channels before boiling occurs. As power increased beyond the point of flow reversal, the maximum wall temperature approaches the fluid saturation temperature, and a thermal excursion occurs. The power limit criterion for low flow rates was the onset of flow reversal. To determine conditions for flow reversal, tests were performed in a mock-up of a fuel assembly that contained two electrically heated concentric tubes surrounded by three flow channels. These tests were modeled using a finite difference thermal-hydraulic code. According to code calculations, flow reversed in the outer flow channel before the maximum wall temperature reached the local fluid saturation temperature. Thermal excursions occurred when the maximum wall temperature approximately equaled the saturation temperature. For a postulated LOPA, the flow reversal criterion for emergency cooling water addition was more limiting than the boiling excursion criterion for full power operation. This criterion limited powers to 37% of the limiting power for previous long-term reactor operations.

29637 (NUREG/CP–0142-Vol.1, pp. 554-573) **Transient pool boiling heat transfer due to increasing heat inputs in subcooled water at high pressures.** Fukuda, K. (Kobe Univ. of Mercantile Marine (Japan)); Shiotsu, M.; Sakurai, A. Nuclear Regulatory Commission, Washington, DC (United States). Div. of Systems Technology; American Nuclear Society, La Grange Park, IL (United States); American Inst. of Chemical Engineers, New York, NY (United States); American Society of Mechanical Engineers, New York, NY (United States); Canadian Nuclear Society, Toronto, ON (Canada); Japan Society of Multiphase Flow, Kyoto (Japan). Sep 1995. (CONF-950904–Vol.1: 7. international meeting on nuclear reactor thermal hydraulics, Saratoga, NY (United States), 10-15 Sep 1995). In *Proceedings of the 7th International Meeting on Nuclear Reactor Thermal-Hydraulics NURETH-7. Volume 1, Sessions 1-5.* 862p. Source: OSTI; NTIS; INIS; GPO.

Understanding of transient boiling phenomenon caused by increasing heat inputs in subcooled water at high pressures is necessary to predict correctly a severe accident due to a power burst in a water-cooled nuclear reactor. Transient maximum heat fluxes, q_{max}, on a 1.2 mm diameter horizontal cylinder in a pool of saturated and subcooled water for exponential heat inputs, $q_o e^{t/T}$, with periods, τ, ranging from about 2 ms to 20 s at pressures from atmospheric up to 2063 kPa for water subcoolings from 0 to about 80 K were measured to obtain the extended data base to investigate the effect of high subcoolings on steady-state and transient maximum heat fluxes, q_{max}. Two main mechanisms of q_{max} exist depending on the exponential periods at low subcoolings. One is due to the time lag of the hydrodynamic instability which starts at steady-state maximum heat flux on fully developed nucleate boiling (FDNB), and the other is due to the heterogenous spontaneous nucleations (HSN) in flooded cavities which coexist with vapor bubbles growing up from active cavities. The shortest period corresponding to the maximum q_{max} for long period range belonging to the former mechanism becomes longer and the q_{max} mechanism for long period range shifts to that due the HSN on FDNB with the increase of subcooling and pressure. The longest period corresponding to the minimum q_{max} for the short period range belonging to the latter mechanism becomes shorter with the increase in saturated pressure. On the contrary, the longest period becomes longer with the increase in subcooling at high pressures. Correlations for steady-state and transient maximum heat fluxes were presented for a wide range of pressure and subcooling.

29638 (NUREG/CP–0142-Vol.1, pp. 574-590) **Cross-sectional void fraction distribution measurements in a vertical annulus two-phase flow by high speed X-ray computed tomography and real-time neutron radiography techniques.** Harvel, G.D. (McMaster Univ., Ontario (Canada)); Hori, K.; Kawanishi, K. Nuclear Regulatory Commission, Washington, DC (United States). Div. of Systems Technology; American Nuclear Society, La Grange Park, IL (United States); American Inst. of Chemical Engineers, New York, NY (United States); American Society of Mechanical Engineers, New York, NY (United States); Canadian Nuclear Society, Toronto, ON (Canada); Japan Society of Multiphase Flow, Kyoto (Japan). Sep 1995. (CONF-950904–Vol.1: 7. international meeting on nuclear reactor thermal hydraulics, Saratoga, NY (United States), 10-15 Sep 1995). In *Proceedings of the 7th International Meeting on Nuclear Reactor Thermal-Hydraulics NURETH-7. Volume 1, Sessions 1-5.* 862p. Source: OSTI; NTIS; INIS; GPO.

A Real-Time Neutron Radiography (RTNR) system and a high speed X-ray Computed tomography (X-CT) system are compared for measurement of two-phase flow. Each system is used to determine the flow regime, and the void fraction distribution in a vertical annulus flow channel. A standard optical video system is also used to observe the flow regime. The annulus flow channel is operated as a bubble column and measurements obtained for gas flow rates from 0.0 to 30.01/min. The flow regimes observed by all three measurement systems through image analysis shows that the two-dimensional void fraction distribution can be obtained. The X-CT system is shown to have a superior temporal resolution capable of resolving the void fraction distribution in an (r,θ) plane in 33.0 ms. Void fraction distribution for bubbly flow and slug flow is determined.

29639 (NUREG/CP–0142-Vol.1, pp. 591-602) **Two-phase velocity measurements around cylinders using particle image velocimetry.** Hassan, Y.A. (Texas A&M Univ., College Station, TX (United States)); Philip, O.G.; Schmidl, W.D. Nuclear Regulatory Commission, Washington, DC (United States). Div. of Systems Technology; American Nuclear Society, La Grange Park, IL (United States); American Inst. of Chemical Engineers, New York, NY (United States); American Society of Mechanical Engineers, New York, NY (United States); Canadian Nuclear Society, Toronto, ON (Canada); Japan Society of Multiphase Flow, Kyoto (Japan). Sep 1995. (CONF-950904–Vol.1: 7. international meeting on nuclear reactor thermal hydraulics, Saratoga, NY (United States), 10-15 Sep 1995). In *Proceedings of the 7th International Meeting on Nuclear Reactor Thermal-Hydraulics NURETH-7. Volume 1, Sessions 1-5.* 862p. Source: OSTI; NTIS; INIS; GPO.

The particle Image Velocimetry flow measurement technique was used to study both single-phase flow and two-phase flow across a cylindrical rod inserted in a channel. First, a flow consisting of only a single-phase fluid was studied. The experiment consisted of running a laminar flow over four rods inserted in a channel. The water flow rate was 126 cm^3/s. Then a two-phase flow was studied. A mixture of water and small air bubbles was used. The water flow rate was 378 cm^3/s and the air flow rate was approximately 30 cm^3/s. The data are analyzed to obtain the velocity fields for both experiments. After interpretation of the velocity data, forces acting on a bubble entrained by the vortex were calculated successfully. The lift and drag coefficients were calculated using the velocity measurements and the force data.

29640 (NUREG/CP–0142-Vol.1, pp. 603-626) **Characteristics of turbulent velocity and temperature in a wall channel of a heated rod bundle.** Krauss, T. (Forschungszentrum Karlsruhe (Germany)); Meyer, L. Nuclear Regulatory Commission, Washington, DC (United States). Div. of Systems Technology; American Nuclear Society, La Grange Park, IL (United States); American Inst. of Chemical Engineers, New York, NY (United States); American Society of Mechanical Engineers, New York, NY (United States); Canadian Nuclear Society, Toronto, ON (Canada); Japan

Society of Multiphase Flow, Kyoto (Japan). Sep 1995. (CONF-950904–Vol.1: 7. international meeting on nuclear reactor thermal hydraulics, Saratoga, NY (United States), 10-15 Sep 1995). In *Proceedings of the 7th International Meeting on Nuclear Reactor Thermal-Hydraulics NURETH-7. Volume 1, Sessions 1-5.* 862p. Source: OSTI; NTIS; INIS; GPO.

Turbulent air flow in a wall sub-channel of a heated 37-rod bundle (P/D = 1.12, W/D = 1.06) was investigated. measurements were performed with hot-wire probe with X-wires and a temperature wire. The mean velocity, the mean fluid temperature, the wall shear stress and wall temperature, the turbulent quantities such as the turbulent kinetic energy, the Reynolds-stresses and the turbulent heat fluxes were measured and are discussed with respect to data from isothermal flow in a wall channel and heated flow in a central channel of the same rod bundle. Also, data on the power spectral densities of the velocity and temperature fluctuations are presented. These data show the existence of large scale periodic fluctuations are responsible for the high intersubchannel heat and momentum exchange.

29641 (NUREG/CP–0142-Vol.1, pp. 627-647) **The coolability limits of a reactor pressure vessel lower head.** Theofanous, T.G. (Univ. of California, Santa Barbara, CA (United States)); Syri, S. Nuclear Regulatory Commission, Washington, DC (United States). Div. of Systems Technology; American Nuclear Society, La Grange Park, IL (United States); American Inst. of Chemical Engineers, New York, NY (United States); American Society of Mechanical Engineers, New York, NY (United States); Canadian Nuclear Society, Toronto, ON (Canada); Japan Society of Multiphase Flow, Kyoto (Japan). Sep 1995. (CONF-950904–Vol.1: 7. international meeting on nuclear reactor thermal hydraulics, Saratoga, NY (United States), 10-15 Sep 1995). In *Proceedings of the 7th International Meeting on Nuclear Reactor Thermal-Hydraulics NURETH-7. Volume 1, Sessions 1-5.* 862p. Source: OSTI; NTIS; INIS; GPO.

Configuration II of the ULPU experimental facility is described, and from a comprehensive set of experiments are provided. The facility affords full-scale simulations of the boiling crisis phenomenon on the hemispherical lower head of a reactor pressure vessel submerged in water, and heated internally. Whereas Configuration I experiments (published previously) established the lower limits of coolability under low submergence, pool-boiling conditions, with Configuration II we investigate coolability under conditions more appropriate to practical interest in severe accident management; that is, heat flux shapes (as functions of angular position) representative of a core melt contained by the lower head, full submergence of the reactor pressure vessel, and natural circulation. Critical heat fluxes as a function of the angular position on the lower head are reported and related the observed two-phase flow regimes.

29642 (NUREG/CP–0142-Vol.1, pp. 648-672) **Numerical simulation of multi-dimensional two-phase flow based on flux vector splitting.** Staedtke, H. (Joint Research Centre - Ispra Establishment (Italy)); Franchello, G.; Worth, B. Nuclear Regulatory Commission, Washington, DC (United States). Div. of Systems Technology; American Nuclear Society, La Grange Park, IL (United States); American Inst. of Chemical Engineers, New York, NY (United States); American Society of Mechanical Engineers, New York, NY (United States); Canadian Nuclear Society, Toronto, ON (Canada); Japan Society of Multiphase Flow, Kyoto (Japan). Sep 1995. (CONF-950904–Vol.1: 7. international meeting on nuclear reactor thermal hydraulics, Saratoga, NY (United States), 10-15 Sep 1995). In *Proceedings of the 7th International Meeting on Nuclear Reactor Thermal-Hydraulics NURETH-7. Volume 1, Sessions 1-5.* 862p. Source: OSTI; NTIS; INIS; GPO.

This paper describes a new approach to the numerical simulation of transient, multidimensional two-phase flow. The development is based on a fully hyperbolic two-fluid model of two-phase flow using separated conservation equations for the two phases. Features of the new model include the existence of real eigenvalues, and a complete set of independent eigenvectors which can be expressed algebraically in terms of the major dependent flow parameters. This facilitates the application of numerical techniques specifically developed for high speed single-phase gas flows which combine signal propagation along characteristic lines with the conservation property with respect to mass, momentum and energy. Advantages of the new model for the numerical simulation of one- and two- dimensional two-phase flow are discussed.

29643 (NUREG/CP–0142-Vol.1, pp. 673-695) **CFD prediction of flow and phase distribution in fuel assemblies with spacers.** Anglart, H. (ABB Atom AB, Vasteras (Switzerland)); Nylund, O.; Kurul, N. Nuclear Regulatory Commission, Washington, DC (United States). Div. of Systems Technology; American Nuclear Society, La Grange Park, IL (United States); American Inst. of Chemical Engineers, New York, NY (United States); American Society of Mechanical Engineers, New York, NY (United States); Canadian Nuclear Society, Toronto, ON (Canada); Japan Society of Multiphase Flow, Kyoto (Japan). Sep 1995. (CONF-950904–Vol.1: 7. international meeting on nuclear reactor thermal hydraulics, Saratoga, NY (United States), 10-15 Sep 1995). In *Proceedings of the 7th International Meeting on Nuclear Reactor Thermal-Hydraulics NURETH-7. Volume 1, Sessions 1-5.* 862p. Source: OSTI; NTIS; INIS; GPO.

This paper is concerned with the modeling and computation of multi-dimensional two-phase flows in BWR fuel assemblies. The modeling principles are presented based on using a two-fluid model in which lateral interfacial effects are accounted for. This model has been used to evaluate the velocity fields of both vapor and liquid phases, as well as phase distribution, between fuel elements in geometries similar to BWR fuel bundles. Furthermore, this model has been used to predict, in a detailed mechanistic manner, the effects of spacers on flow and phase distribution between, and pressure drop along, fuel elements. The related numerical simulations have been performed using a CFD computer code, CFDS-FLOW3D.

29644 (NUREG/CP–0142-Vol.1, pp. 696-710) **Computational fluid dynamic analysis of a closure head penetration in a pressurized water reactor.** Forsyth, D.R. (Westinghouse Electric Corp., Pittsburgh, PA (United States)); Schwirian, R.E. Nuclear Regulatory Commission, Washington, DC (United States). Div. of Systems Technology; American Nuclear Society, La Grange Park, IL (United States); American Inst. of Chemical Engineers, New York, NY (United States); American Society of Mechanical Engineers, New York, NY (United States); Canadian Nuclear Society, Toronto, ON (Canada); Japan Society of Multiphase Flow, Kyoto (Japan). Sep 1995. (CONF-950904–Vol.1: 7. international meeting on nuclear reactor thermal hydraulics, Saratoga, NY (United States), 10-15 Sep 1995). In *Proceedings of the 7th International Meeting on Nuclear Reactor Thermal-Hydraulics NURETH-7. Volume 1, Sessions 1-5.* 862p. Source: OSTI; NTIS; INIS; GPO.

ALLOY 600 has been used typically for penetrations through the closure head in pressurized water reactors because of its thermal compatibility with carbon steel, superior resistance to chloride attack and higher strength than the austenitic stainless steels. Recent plant operating experience with this alloy has indicated that this material may be susceptible to degradation. One of the major parameters relating to degradation of the head penetrations are the operational temperatures and stress levels in the penetration.

29645 (NUREG/CP–0142-Vol.1, pp. 711-719) **THEHYCO-3DT: Thermal hydrodynamic code for the 3 dimensional transient calculation of advanced LMFBR core.** Vitruk, S.G. (Moscow Engineering Physics Institute (Russian Federation)); Korsun, A.S.; Ushakov, P.A. Nuclear Regulatory Commission, Washington, DC (United States). Div. of Systems Technology; American Nuclear Society, La Grange Park, IL (United States); American Inst. of Chemical Engineers, New York, NY (United States); American Society of Mechanical Engineers, New York, NY (United States); Canadian Nuclear Society, Toronto, ON (Canada); Japan Society of Multiphase Flow, Kyoto (Japan). Sep 1995. (CONF-950904–Vol.1: 7. international meeting on nuclear reactor thermal hydraulics, Saratoga, NY (United States), 10-15 Sep 1995). In *Proceedings of the 7th International Meeting on Nuclear Reactor Thermal-Hydraulics NURETH-7. Volume 1, Sessions 1-5.* 862p. Source: OSTI; NTIS; INIS; GPO.

The multilevel mathematical model of neutron thermal hydrodynamic processes in a passive safety core without assemblies duct walls and appropriate computer code SKETCH, consisted of thermal hydrodynamic module THEHYCO-3DT and neutron one, are described. A new effective discretization technique for energy, momentum and mass conservation equations is applied in hexagonal

- z geometry. The model adequacy and applicability are presented. The results of the calculations show that the model and the computer code could be used in conceptual design of advanced reactors.

29646 (NUREG/CP–0142-Vol.1, pp. 720-735) **Transition to chaos in a square enclosure containing internal heat sources.** Baytas, A.C. (Institute For Nuclear Energy, Istanbul (Turkey)). Nuclear Regulatory Commission, Washington, DC (United States). Div. of Systems Technology; American Nuclear Society, La Grange Park, IL (United States); American Inst. of Chemical Engineers, New York, NY (United States); American Society of Mechanical Engineers, New York, NY (United States); Canadian Nuclear Society, Toronto, ON (Canada); Japan Society of Multiphase Flow, Kyoto (Japan). Sep 1995. (CONF-950904–Vol.1: 7. international meeting on nuclear reactor thermal hydraulics, Saratoga, NY (United States), 10-15 Sep 1995). In *Proceedings of the 7th International Meeting on Nuclear Reactor Thermal-Hydraulics NURETH-7. Volume 1, Sessions 1-5.* 862p. Source: OSTI; NTIS; INIS; GPO.

A numerical investigation is performed to study the transition from steady to chaotic flow of a fluid confined in a two-dimensional square cavity. The cavity has rigid walls of constant temperature containing uniformly distributed internal heat source. Effects of the Rayleigh number of flow and heat transfer rates are studied. In addition to, same problem is solved for sinusoidally changing internal heat source to show its effect on the flow model and heat transfer of the enclosures. Details of oscillatory solutions and flow bifurcations are presented.

29647 (NUREG/CP–0142-Vol.1, pp. 736-749) **ASTRID: A 3D Eulerian software for subcooled boiling modelling - comparison with experimental results in tubes and annuli.** Briere, E. (Electricite de France, Chatou (France)); Larrauri, D.; Olive, J. Nuclear Regulatory Commission, Washington, DC (United States). Div. of Systems Technology; American Nuclear Society, La Grange Park, IL (United States); American Inst. of Chemical Engineers, New York, NY (United States); American Society of Mechanical Engineers, New York, NY (United States); Canadian Nuclear Society, Toronto, ON (Canada); Japan Society of Multiphase Flow, Kyoto (Japan). Sep 1995. (CONF-950904–Vol.1: 7. international meeting on nuclear reactor thermal hydraulics, Saratoga, NY (United States), 10-15 Sep 1995). In *Proceedings of the 7th International Meeting on Nuclear Reactor Thermal-Hydraulics NURETH-7. Volume 1, Sessions 1-5.* 862p. Source: OSTI; NTIS; INIS; GPO.

For about four years, Electricite de France has been developing a 3-D computer code for the Eulerian simulation of two-phase flows. This code, named ASTRID, is based on the six-equation two-fluid model. Boiling water flows, such as those encountered in nuclear reactors, are among the main applications of ASTRID. In order to provide ASTRID with closure laws and boundary conditions suitable for boiling flows, a boiling model has been developed by EDF and the Institut de Mecanique des Fluides de Toulouse. In the fluid, the heat and mass transfer between a bubble and the liquid is being modelled. At the heating wall, the incipient boiling point is determined according to Hsu's criterion and the boiling heat flux is split into three additive terms: a convective term, a quenching term and a vaporisation term. This model uses several correlations. EDF's program in boiling two-phase flows also includes experimental studies, some of which are performed in collaboration with other laboratories. Refrigerant subcooled boiling both in tubular (DEBORA experiment, CEN Grenoble) and in annular geometry (Arizona State University Experiment) have been computed with ASTRID. The simulations show the satisfactory results already obtained on void fraction and liquid temperature. Ways of improvement of the model are drawn especially on the dynamical part.

29648 (NUREG/CP–0142-Vol.1, pp. 750-769) **The multi-dimensional module of CATHARE 2 description and application.** Barre, F. (French Atomic Energy Commission (C.E.A.), Grenoble (France)); Dor, I.; Sun, C. Nuclear Regulatory Commission, Washington, DC (United States). Div. of Systems Technology; American Nuclear Society, La Grange Park, IL (United States); American Inst. of Chemical Engineers, New York, NY (United States); American Society of Mechanical Engineers, New York, NY (United States); Canadian Nuclear Society, Toronto, ON (Canada); Japan Society of Multiphase Flow, Kyoto (Japan). Sep 1995. (CONF-950904–Vol.1: 7. international meeting on nuclear reactor thermal hydraulics, Saratoga, NY (United States), 10-15 Sep 1995). In *Proceedings of the 7th International Meeting on Nuclear Reactor Thermal-Hydraulics NURETH-7. Volume 1, Sessions 1-5.* 862p. Source: OSTI; NTIS; INIS; GPO.

In this paper, the three-dimensional module of CATHARE 2 is presented. It is based on a two-phase-flow six-equation model. A predictor/corrector multistep method, with an implicit behavior, is used to discretize the equations. Blowdown and boil-of analytical tests are used for an initial validation of the module. UPTF downcomer refill tests simulating the refill phase of a large-break loss-of-coolant accident are calculated. Additional models, including molecular and turbulent diffusion, are added in order to perform containment calculations.

29649 (NUREG/CP–0142-Vol.1, pp. 770-780) **Reflooding and boil-off experiments in a VVER-440 like rod bundle and analyses with the CATHARE code.** Korteniemi, V. (Lappeenranta Univ. of Technology (Finland)); Haapalehto, T.; Puustinen, M. Nuclear Regulatory Commission, Washington, DC (United States). Div. of Systems Technology; American Nuclear Society, La Grange Park, IL (United States); American Inst. of Chemical Engineers, New York, NY (United States); American Society of Mechanical Engineers, New York, NY (United States); Canadian Nuclear Society, Toronto, ON (Canada); Japan Society of Multiphase Flow, Kyoto (Japan). Sep 1995. (CONF-950904–Vol.1: 7. international meeting on nuclear reactor thermal hydraulics, Saratoga, NY (United States), 10-15 Sep 1995). In *Proceedings of the 7th International Meeting on Nuclear Reactor Thermal-Hydraulics NURETH-7. Volume 1, Sessions 1-5.* 862p. Source: OSTI; NTIS; INIS; GPO.

Several experiments were performed with the VEERA facility to simulate reflooding and boil-off phenomena in a VVER-440 like rod bundle. The objective of these experiments was to get experience of a full-scale bundle behavior and to create a database for verification of VVER type core models used with modern thermal-hydraulic codes. The VEERA facility used in the experiments is a scaled-down model of the Russian VVER-440 type pressurized water reactors used in Loviisa, Finland. The test section of the facility consists of one full-scale copy of a VVER-440 reactor rod bundle with 126 full-length electrically heated rod simulators. Bottom and top-down reflooding, different modes of emergency core cooling (ECC) injection and the effect of heating power on the heat-up of the rods was studied. In this paper the results of calculations simulating two reflood and one boil-off experiment with the French CATHARE2 thermal-hydraulic code are also presented. Especially the performance of the recently implemented top-down reflood model of the code was studied.

29650 (NUREG/CP–0142-Vol.1, pp. 781-803) **Counter-current flow in a vertical to horizontal tube with obstructions.** Tye, P. (Institut de Genie Nucleaire, Quebec (Canada)); Matuszkiewicz, A.; Teyssedou, A. Nuclear Regulatory Commission, Washington, DC (United States). Div. of Systems Technology; American Nuclear Society, La Grange Park, IL (United States); American Inst. of Chemical Engineers, New York, NY (United States); American Society of Mechanical Engineers, New York, NY (United States); Canadian Nuclear Society, Toronto, ON (Canada); Japan Society of Multiphase Flow, Kyoto (Japan). Sep 1995. (CONF-950904–Vol.1: 7. international meeting on nuclear reactor thermal hydraulics, Saratoga, NY (United States), 10-15 Sep 1995). In *Proceedings of the 7th International Meeting on Nuclear Reactor Thermal-Hydraulics NURETH-7. Volume 1, Sessions 1-5.* 862p. Source: OSTI; NTIS; INIS; GPO.

This paper presents experimental results on counter-current flow and flooding in an elbow between a vertical and a horizontal run. The experimental technique used allowed not only the flooding limit to be determined, but also the entire partial delivery region to be studied as well. The influence that various size orifices placed in the horizontal run have on both the delivered liquid flow rates and on the flooding limits is also examined. It is observed that both the flooding limits and the delivered liquid flow rates decrease with decreasing orifice size. Further, it is also observed that the mechanisms that govern the partial delivery of the liquid are significantly different when an orifice is present in the horizontal leg as compared to the case when no orifice is present.

29651 (NUREG/CP–0142-Vol.1, pp. 804-814) **Flooding characteristics of gas-liquid two-phase flow in a horizontal U bend pipe.** Sakaguchi, T. (Kobe Univ. (Japan)); Hosokawa, S.; Fujii, Y. Nuclear Regulatory Commission, Washington, DC (United States). Div. of Systems Technology; American Nuclear Society, La Grange Park, IL (United States); American Inst. of Chemical Engineers, New York, NY (United States); American Society of Mechanical Engineers, New York, NY (United States); Canadian Nuclear Society, Toronto, ON (Canada); Japan Society of Multiphase Flow, Kyoto (Japan). Sep 1995. (CONF-950904–Vol.1: 7. international meeting on nuclear reactor thermal hydraulics, Saratoga, NY (United States), 10-15 Sep 1995). In *Proceedings of the 7th International Meeting on Nuclear Reactor Thermal-Hydraulics NURETH-7. Volume 1, Sessions 1-5.* 862p. Source: OSTI; NTIS; INIS; GPO.

For next-generation nuclear reactors, hybrid safety systems which consist of active and passive safety systems have been planned. Steam generators with horizontal U bend pipelines will be used as one of the passive safety systems. It is required to clarify flow characteristics, especially the onset of flooding, in the horizontal U bend pipelines in order to examine their safety. Flooding in vertical pipes has been studied extensively. However, there is little study on flooding in the horizontal U bend pipelines. It is supposed that the onset of flooding in the horizontal U bend pipelines is different from that in vertical pipes. On the other hand, liquid is generated due to condensation of steam in pipes of the horizontal steam generators at the loss of coolant accident because the steam generators will be used as a condenser of a cooling system of steam from the reactor. It is necessary to simulate this situation by the supply of water at the middle of horizontal pipe. In the present paper, experiments were carried out using a horizontal U bend pipeline with a liquid supply section in the midway of pipeline. The onset of flooding in the horizontal U bend pipeline was measured. Effects of the length of horizontal pipe and the radius of U bend on the onset of flooding were discussed.

29652 (NUREG/CP–0142-Vol.1, pp. 815-826) **CCFL in hot legs and steam generators and its prediction with the CATHARE code.** Geffraye, G. (CEA/DRN/STR, Grenoble (France)); Bazin, P.; Pichon, P. Nuclear Regulatory Commission, Washington, DC (United States). Div. of Systems Technology; American Nuclear Society, La Grange Park, IL (United States); American Inst. of Chemical Engineers, New York, NY (United States); American Society of Mechanical Engineers, New York, NY (United States); Canadian Nuclear Society, Toronto, ON (Canada); Japan Society of Multiphase Flow, Kyoto (Japan). Sep 1995. (CONF-950904–Vol.1: 7. international meeting on nuclear reactor thermal hydraulics, Saratoga, NY (United States), 10-15 Sep 1995). In *Proceedings of the 7th International Meeting on Nuclear Reactor Thermal-Hydraulics NURETH-7. Volume 1, Sessions 1-5.* 862p. Source: OSTI; NTIS; INIS; GPO.

This paper presents a study about the Counter-Current Flow Limitation (CCFL) prediction in hot legs and steam generators (SG) in both system test facilities and pressurized water reactors. Experimental data are analyzed, particularly the recent MHYRESA test data. Geometrical and scale effects on the flooding behavior are shown. The CATHARE code modelling problems concerning the CCFL prediction are discussed. A method which gives the user the possibility of controlling the flooding limit at a given location is developed. In order to minimize the user effect, a methodology is proposed to the user in case of a calculation with a counter-current flow between the upper plenum and the SF U-tubes. The following questions have to be made clear for the user: when to use the CATHARE CCFL option, which correlation to use, and where to locate the flooding limit.

29653 (NUREG/CP–0142-Vol.2, pp. 827-845) **On heat transfer characteristics of real and simulant melt pool experiments.** Dinh, T.N. (Royal Institute of Technology, Stockholm (Sweden)); Nourgaliev R.R.; Sehgal, B.R. Nuclear Regulatory Commission, Washington, DC (United States). Div. of Systems Technology; American Nuclear Society, La Grange Park, IL (United States); American Inst. of Chemical Engineers, New York, NY (United States); American Society of Mechanical Engineers, New York, NY (United States); Canadian Nuclear Society, Toronto, ON (Canada); European Nuclear Society (ENS), Bern (Switzerland); Atomic Energy Society of Japan, Tokyo (Japan); Japan Society of Multiphase Flow, Kyoto (Japan). Sep 1995. (CONF-950904–Vol.2: 7. international meeting on nuclear reactor thermal hydraulics, Saratoga, NY (United States), 10-15 Sep 1995). In *Proceedings of the 7th International Meeting on Nuclear Reactor Thermal-Hydraulics NURETH-7. Volume 2, Sessions 6-11.* 795p. Source: OSTI; NTIS; INIS; GPO.

The paper presents results of analytical studies of natural convection heat transfer in scaled and/or simulant melt pool experiments related to the PWR in-vessel melt retention issue. Specific reactor-scale effects of a large decay-heated core melt pool in the reactor pressure vessel lower plenum are first reviewed, and then the current analytical capability of describing physical processes under prototypical situations is examined. Experiments and experimental approaches are analysed by focusing on their ability to represent prototypical situations. Calculations are carried out in order to assess the significance of some selected effects, including variations in melt properties, pool geometry and heating conditions. Rayleigh numbers in the present analysis are limited to 10^{12}, where uncertainties in turbulence modeling are not overriding other uncertainties. The effects of fluid Prandtl number on heat transfer to the lowermost part of cooled pool walls are examined for square and semicircular cavities. Calculations are performed also to explore limitations of using side-wall heating and direct electrical heating in reproducing the physical picture of interest. Needs for further experimental and analytical efforts are discussed as well.

29654 (NUREG/CP–0142-Vol.2, pp. 846-853) **Passive decay heat removal by natural air convection after severe accidents.** Erbacher, F.J. (Forschungszentrum Karlsruhe Institut fur Angewandte Thermo- und Fluiddynamik, Karlsruhe (Germany)); Neitzel, H.J.; Cheng, X. Nuclear Regulatory Commission, Washington, DC (United States). Div. of Systems Technology; American Nuclear Society, La Grange Park, IL (United States); American Inst. of Chemical Engineers, New York, NY (United States); American Society of Mechanical Engineers, New York, NY (United States); Canadian Nuclear Society, Toronto, ON (Canada); European Nuclear Society (ENS), Bern (Switzerland); Atomic Energy Society of Japan, Tokyo (Japan); Japan Society of Multiphase Flow, Kyoto (Japan). Sep 1995. Project 15NU0961. (CONF-950904–Vol.2: 7. international meeting on nuclear reactor thermal hydraulics, Saratoga, NY (United States), 10-15 Sep 1995). In *Proceedings of the 7th International Meeting on Nuclear Reactor Thermal-Hydraulics NURETH-7. Volume 2, Sessions 6-11.* 795p. Source: OSTI; NTIS; INIS; GPO.

The composite containment proposed by the Research Center Karlsruhe and the Technical University Karlsruhe is to cope with severe accidents. It pursues the goal to restrict the consequences of core meltdown accidents to the reactor plant. One essential of this new containment concept is its potential to remove the decay heat by natural air convection and thermal radiation in a passive way. To investigate the coolability of such a passive cooling system and the physical phenomena involved, experimental investigations are carried out at the PASCO test facility. Additionally, numerical calculations are performed by using different codes. A satisfying agreement between experimental data and numerical results is obtained.

29655 (NUREG/CP–0142-Vol.2, pp. 854-864) **Natural circulation in a VVER reactor geometry: Experiments with the PACTEL facility and Cathare simulations.** Raussi, P. (Lappeenranta Univ. of Technology, Lappeenranta (Finland)); Kainulainen, S.; Kouhia, J. Nuclear Regulatory Commission, Washington, DC (United States). Div. of Systems Technology; American Nuclear Society, La Grange Park, IL (United States); American Inst. of Chemical Engineers, New York, NY (United States); American Society of Mechanical Engineers, New York, NY (United States); Canadian Nuclear Society, Toronto, ON (Canada); European Nuclear Society (ENS), Bern (Switzerland); Atomic Energy Society of Japan, Tokyo (Japan); Japan Society of Multiphase Flow, Kyoto (Japan). Sep 1995. (CONF-950904–Vol.2: 7. international meeting on nuclear reactor thermal hydraulics, Saratoga, NY (United States), 10-15 Sep 1995). In *Proceedings of the 7th International*

Meeting on Nuclear Reactor Thermal-Hydraulics NURETH-7. Volume 2, Sessions 6-11. 795p. Source: OSTI; NTIS; INIS; GPO.

There are some 40 reactors based on the VVER design in use. Database available for computer code assessment for VVER reactors is rather limited. Experiments were conducted to study natural circulation behaviour in the PACTEL facility, a medium-scale integral test loop patterned after VVER pressurized water reactors. Flow behaviour over a range of coolant inventories was studied with a small-break experiment. In the small-break experiments, flow stagnation and system repressurization were observed when the water level in the upper plenum fell below the entrances to the hot legs. The cause was attributed to the hot leg loop seals, which are a unique feature of the VVER geometry. At low primary inventories, core cooling was achieved through the boiler-condenser mode. The experiment was simulated using French thermalhydraulic system code CATHARE.

29656 (NUREG/CP–0142-Vol.2, pp. 864-874) **Parametric numerical investigaion of natural convection in a heat-generating fluid with phase transitions.** Aksenova, A.E. (Institute of Nuclear Safety Russian Academy Science, Moscow (Russian Federation)); Chudanov, V.V.; Strizhov, V.F.; Vabishchevich, P.N. Nuclear Regulatory Commission, Washington, DC (United States). Div. of Systems Technology; American Nuclear Society, La Grange Park, IL (United States); American Inst. of Chemical Engineers, New York, NY (United States); American Society of Mechanical Engineers, New York, NY (United States); Canadian Nuclear Society, Toronto, ON (Canada); European Nuclear Society (ENS), Bern (Switzerland); Atomic Energy Society of Japan, Tokyo (Japan); Japan Society of Multiphase Flow, Kyoto (Japan). Sep 1995. (CONF-950904–Vol.2: 7. international meeting on nuclear reactor thermal hydraulics, Saratoga, NY (United States), 10-15 Sep 1995). In *Proceedings of the 7th International Meeting on Nuclear Reactor Thermal-Hydraulics NURETH-7. Volume 2, Sessions 6-11.* 795p. Source: OSTI; NTIS; INIS; GPO.

Unsteady natural convection of a heat-generating fluid with phase transitions in the enclosures of a square section with isothermal rigid walls is investigated numerically for a wide range of dimensionless parameters. The quasisteady state solutions of conjugate heat and mass transfer problem are compared with available experimental results. Correlation relations for heat flux distributions at the domain boundaries depending on Rayleigh and Ostrogradskii numbers are obtained. It is shown that generally heat transfer is governed both by natural circulation and crust formation phenomena. Results of this paper may be used for analysis of experiments with prototypic core materials.

29657 (NUREG/CP–0142-Vol.2, pp. 875-887) **Geysering in boiling channels.** Aritomi, Masanori (Tokyo Institute of Technology, Tokyo (Japan)); Takemoto, Takatoshi; Chiang, Jing-Hsien. Nuclear Regulatory Commission, Washington, DC (United States). Div. of Systems Technology; American Nuclear Society, La Grange Park, IL (United States); American Inst. of Chemical Engineers, New York, NY (United States); American Society of Mechanical Engineers, New York, NY (United States); Canadian Nuclear Society, Toronto, ON (Canada); European Nuclear Society (ENS), Bern (Switzerland); Atomic Energy Society of Japan, Tokyo (Japan); Japan Society of Multiphase Flow, Kyoto (Japan). Sep 1995. (CONF-950904–Vol.2: 7. international meeting on nuclear reactor thermal hydraulics, Saratoga, NY (United States), 10-15 Sep 1995). In *Proceedings of the 7th International Meeting on Nuclear Reactor Thermal-Hydraulics NURETH-7. Volume 2, Sessions 6-11.* 795p. Source: OSTI; NTIS; INIS; GPO.

A concept of natural circulation BWRs such as the SBWR has been proposed and seems to be promising in that the primary cooling system can be simplified. The authors have been investigating thermo-hydraulic instabilities which may appear during the start-up in natural circulation BWRs. In our previous works, geysering was investigated in parallel boiling channels for both natural and forced circulations, and its driving mechanism and the effect of system pressure on geysering occurrence were made clear. In this paper, geysering is investigated in a vertical column and a U-shaped vertical column heated in the lower parts. It is clarified from the results that the occurrence mechanism of geysering and the dependence of system pressure on geysering occurrence coincide between parallel boiling channels in circulation systems and vertical columns in non-circulation systems.

29658 (NUREG/CP–0142-Vol.2, pp. 888-910) **Two-phase flow stability structure in a natural circulation system.** Zhou, Zhiwei (Nuclear Engineering Laboratory Zurich (Switzerland)). Nuclear Regulatory Commission, Washington, DC (United States). Div. of Systems Technology; American Nuclear Society, La Grange Park, IL (United States); American Inst. of Chemical Engineers, New York, NY (United States); American Society of Mechanical Engineers, New York, NY (United States); Canadian Nuclear Society, Toronto, ON (Canada); European Nuclear Society (ENS), Bern (Switzerland); Atomic Energy Society of Japan, Tokyo (Japan); Japan Society of Multiphase Flow, Kyoto (Japan). Sep 1995. (CONF-950904–Vol.2: 7. international meeting on nuclear reactor thermal hydraulics, Saratoga, NY (United States), 10-15 Sep 1995). In *Proceedings of the 7th International Meeting on Nuclear Reactor Thermal-Hydraulics NURETH-7. Volume 2, Sessions 6-11.* 795p. Source: OSTI; NTIS; INIS; GPO.

The present study reports a numerical analysis of two-phase flow stability structures in a natural circulation system with two parallel, heated channels. The numerical model is derived, based on the Galerkin moving nodal method. This analysis is related to some design options applicable to integral heating reactors with a slightly-boiling operation mode, and is also of general interest to similar facilities. The options include: (1) Symmetric heating and throttling; (2) Asymmetric heating and symmetric throttling; (3) Asymmetric heating and throttling. The oscillation modes for these variants are discussed. Comparisons with the data from the INET two-phase flow stability experiment have qualitatively validated the present analysis.

29659 (NUREG/CP–0142-Vol.2, pp. 911-922) **FIBWR2 evaluation of fuel thermal limits during density wave oscillaions in BWRs.** Nik, N. (New York Power Authority, White Plains, NY (United States)); Rajan, S.R.; Karasulu, M. Nuclear Regulatory Commission, Washington, DC (United States). Div. of Systems Technology; American Nuclear Society, La Grange Park, IL (United States); American Inst. of Chemical Engineers, New York, NY (United States); American Society of Mechanical Engineers, New York, NY (United States); Canadian Nuclear Society, Toronto, ON (Canada); European Nuclear Society (ENS), Bern (Switzerland); Atomic Energy Society of Japan, Tokyo (Japan); Japan Society of Multiphase Flow, Kyoto (Japan). Sep 1995. (CONF-950904–Vol.2: 7. international meeting on nuclear reactor thermal hydraulics, Saratoga, NY (United States), 10-15 Sep 1995). In *Proceedings of the 7th International Meeting on Nuclear Reactor Thermal-Hydraulics NURETH-7. Volume 2, Sessions 6-11.* 795p. Source: OSTI; NTIS; INIS; GPO.

Analyses were performed to evaluate hydraulic and thermal margin responses of three different BWR fuel designs subjected to the same periodic power/flow oscillations, such as those that might be exhibited during an instability event. The power/flow versus time information from the oscillations was used as a forcing function to calculate the hydraulic response and the MCPR performance of the limiting fuel bundles during the regional oscillations using the analytical code FIBWR2. The results of the calculations were used to determine the thermal margin variation as a function of oscillation magnitude.

29660 (NUREG/CP–0142-Vol.2, pp. 923-932) **Density wave oscillations of a boiling natural circulation loop induced by flashing.** Furuya, Masahiro (Central Research Institute of Electric Power Industry, Tokyo (Japan)); Inada, Fumio; Yasuo, Akira. Nuclear Regulatory Commission, Washington, DC (United States). Div. of Systems Technology; American Nuclear Society, La Grange Park, IL (United States); American Inst. of Chemical Engineers, New York, NY (United States); American Society of Mechanical Engineers, New York, NY (United States); Canadian Nuclear Society, Toronto, ON (Canada); European Nuclear Society (ENS), Bern (Switzerland); Atomic Energy Society of Japan, Tokyo (Japan); Japan Society of Multiphase Flow, Kyoto (Japan). Sep 1995. (CONF-950904–Vol.2: 7. international meeting on nuclear reactor thermal hydraulics, Saratoga, NY (United States), 10-15 Sep 1995). In *Proceedings of the 7th International Meeting on Nuclear*

Reactor Thermal-Hydraulics NURETH-7. Volume 2, Sessions 6-11. 795p. Source: OSTI; NTIS; INIS; GPO.

Experiments are conducted to investigate two-phase flow instabilities in a boiling natural circulation loop with a chimney due to flashing in the chimney at lower pressure. The test facility used in this experiment is designed to have non-dimensional values which are nearly equal to those of natural circulation BWR. Stability maps in reference to the heat flux, the inlet subcooling, the system pressure are presented. This instability is suggested to be density wave oscillations due to flashing in the chimney, and the differences from other phenomena such as flow pattern oscillations and geysering phenomena are discussed by investigating the dynamic characteristics, the oscillation period, and the transient flow pattern.

29661 (NUREG/CP–0142-Vol.2, pp. 947-966) **Two-phase flow instabilities in a vertical annular channel.** Babelli, I. (Purdue Univ., West Lafayette, IN (United States)); Nair, S.; Ishii, M. Nuclear Regulatory Commission, Washington, DC (United States). Div. of Systems Technology; American Nuclear Society, La Grange Park, IL (United States); American Inst. of Chemical Engineers, New York, NY (United States); American Society of Mechanical Engineers, New York, NY (United States); Canadian Nuclear Society, Toronto, ON (Canada); European Nuclear Society (ENS), Bern (Switzerland); Atomic Energy Society of Japan, Tokyo (Japan); Japan Society of Multiphase Flow, Kyoto (Japan). Sep 1995. (CONF-950904–Vol.2: 7. international meeting on nuclear reactor thermal hydraulics, Saratoga, NY (United States), 10-15 Sep 1995). In *Proceedings of the 7th International Meeting on Nuclear Reactor Thermal-Hydraulics NURETH-7. Volume 2, Sessions 6-11.* 795p. Source: OSTI; NTIS; INIS; GPO.

An experimental test facility was built to study two-phase flow instabilities in vertical annular channel with emphasis on downward flow under low pressure and low flow conditions. The specific geometry of the test section is similar to the fuel-target sub-channel of the Savannah River Site (SRS) Mark 22 fuel assembly. Critical Heat Flux (CHF) was observed following flow excursion and flow reversal in the test section. Density wave instability was not recorded in this series of experimental runs. The results of this experimental study show that flow excursion is the dominant instability mode under low flow, low pressure, and down flow conditions. The onset of instability data are plotted on the subcooling-Zuber (phase change) numbers stability plane.

29662 (NUREG/CP–0142-Vol.2, pp. 967-1002) **Problems in experimental and mathematical investigations of the accidental thermohydraulic processes in RBMK nuclear reactors.** Nigmatulin, B.I. (Engineering Centre (EREC) for Nuclear Plants Safety, Electrogorsk (Russian Federation)); Tikhonenko, L.K.; Blinkov, V.N. Nuclear Regulatory Commission, Washington, DC (United States). Div. of Systems Technology; American Nuclear Society, La Grange Park, IL (United States); American Inst. of Chemical Engineers, New York, NY (United States); American Society of Mechanical Engineers, New York, NY (United States); Canadian Nuclear Society, Toronto, ON (Canada); European Nuclear Society (ENS), Bern (Switzerland); Atomic Energy Society of Japan, Tokyo (Japan); Japan Society of Multiphase Flow, Kyoto (Japan). Sep 1995. (CONF-950904–Vol.2: 7. international meeting on nuclear reactor thermal hydraulics, Saratoga, NY (United States), 10-15 Sep 1995). In *Proceedings of the 7th International Meeting on Nuclear Reactor Thermal-Hydraulics NURETH-7. Volume 2, Sessions 6-11.* 795p. Source: OSTI; NTIS; INIS; GPO.

In this paper the thermalhydraulic scheme and peculiarities of the boiling water graphite-moderated channel-type reactor RBMK are presented and discussed shortly. The essential for RBMK transient regimes, accidental situations and accompanying thermalhydraulic phenomena and processes are formulated. These data are presented in the form of cross reference matrix (version 1) for system computer codes verification. The paper includes qualitative analysis of the computer codes and integral facilities which have been used or can be used for RBMK transients and accidents investigations. The stability margins for RBMK-1000 and RBMK-1500 are shown.

29663 (NUREG/CP–0142-Vol.2, pp. 1003-1021) **Modeling and numerical simulation of oscillatory two-phase flows, with application to boiling water nuclear reactors.** Rosa, M.P. (Instituto de Estudos Avancados - CTA, Sao Paolo (Brazil)); Podowski, M.Z. Nuclear Regulatory Commission, Washington, DC (United States). Div. of Systems Technology; American Nuclear Society, La Grange Park, IL (United States); American Inst. of Chemical Engineers, New York, NY (United States); American Society of Mechanical Engineers, New York, NY (United States); Canadian Nuclear Society, Toronto, ON (Canada); European Nuclear Society (ENS), Bern (Switzerland); Atomic Energy Society of Japan, Tokyo (Japan); Japan Society of Multiphase Flow, Kyoto (Japan). Sep 1995. (CONF-950904–Vol.2: 7. international meeting on nuclear reactor thermal hydraulics, Saratoga, NY (United States), 10-15 Sep 1995). In *Proceedings of the 7th International Meeting on Nuclear Reactor Thermal-Hydraulics NURETH-7. Volume 2, Sessions 6-11.* 795p. Source: OSTI; NTIS; INIS; GPO.

This paper is concerned with the analysis of dynamics and stability of boiling channels and systems. The specific objectives are two-fold. One of them is to present the results of a study aimed at analyzing the effects of various modeling concepts and numerical approaches on the transient response and stability of parallel boiling channels. The other objective is to investigate the effect of closed-loop feedback on stability of a boiling water reactor (BWR). Various modeling and computational issues for parallel boiling channels are discussed, such as: the impact of the numerical discretization scheme for the node containing the moving boiling boundary on the convergence and accuracy of computations, and the effects of subcooled boiling and other two-phase flow phenomena on the predictions of marginal stability conditions. Furthermore, the effects are analyzed of local loss coefficients around the recirculation loop of a boiling water reactor on stability of the reactor system. An apparent paradox is explained concerning the impact of changing single-phase losses on loop stability. The calculations have been performed using the DYNOBOSS computer code. The results of DYNOBOSS validation against other computer codes and experimental data are shown.

29664 (NUREG/CP–0142-Vol.2, pp. 1022-1031) **Thermal-hydraulic instabilities in pressure tube graphite - moderated boiling water reactors.** Tsiklauri, G.; Schmitt, B. Nuclear Regulatory Commission, Washington, DC (United States). Div. of Systems Technology; American Nuclear Society, La Grange Park, IL (United States); American Inst. of Chemical Engineers, New York, NY (United States); American Society of Mechanical Engineers, New York, NY (United States); Canadian Nuclear Society, Toronto, ON (Canada); European Nuclear Society (ENS), Bern (Switzerland); Atomic Energy Society of Japan, Tokyo (Japan); Japan Society of Multiphase Flow, Kyoto (Japan). Sep 1995. (CONF-950904–Vol.2: 7. international meeting on nuclear reactor thermal hydraulics, Saratoga, NY (United States), 10-15 Sep 1995). In *Proceedings of the 7th International Meeting on Nuclear Reactor Thermal-Hydraulics NURETH-7. Volume 2, Sessions 6-11.* 795p. Source: OSTI; NTIS; INIS; GPO.

Thermally induced two-phase instabilities in non-uniformly heated boiling channels in RBMK-1000 reactor have been analyzed using RELAP5/MOD3 code. The RELAP5 model of a RBMK-1000 reactor was developed to investigate low flow in a distribution group header (DGH) supplying 44 fuel pressure tubes. The model was evaluated against experimental data. The results of the calculations indicate that the period of oscillation for the high power tube varied from 3.1s to 2.6s, over the power range of 2.0 MW to 3.0 MW, respectively. The amplitude of the flow oscillation for the high powered tube varied from +100% to -150% of the tube average flow. Reverse flow did not occur in the lower power tubes. The amplitude of oscillation in the subcooled region at the inlet to the fuel region is higher than in the saturated region at the outlet. In the upper fuel region and outlet connectors the flow oscillations are dissipated. The threshold of flow instability for the high powered tubes of a RBMK reactor is compared to Japanese data and appears to be in good agreement.

29665 (NUREG/CP–0142-Vol.2, pp. 1032-1045) **Dynamics of shock wave propagation and interphase process in liquid-vapor medium.** Pokusaev, B.G. (Moscow State Academy of Chemical Mechanical Engineering (Russian Federation)); Pribaturin, N.A. Nuclear Regulatory Commission, Washington, DC (United States). Div. of Systems Technology; American Nuclear Society, La Grange Park, IL (United States); American Inst. of

Chemical Engineers, New York, NY (United States); American Society of Mechanical Engineers, New York, NY (United States); Canadian Nuclear Society, Toronto, ON (Canada); European Nuclear Society (ENS), Bern (Switzerland); Atomic Energy Society of Japan, Tokyo (Japan); Japan Society of Multiphase Flow, Kyoto (Japan). Sep 1995. Grant N 94-02-03971. (CONF-950904--Vol.2: 7. international meeting on nuclear reactor thermal hydraulics, Saratoga, NY (United States), 10-15 Sep 1995). In *Proceedings of the 7th International Meeting on Nuclear Reactor Thermal-Hydraulics NURETH-7. Volume 2, Sessions 6-11.* 795p. Source: OSTI; NTIS; INIS; GPO.

This paper considers the experimental results and physical effects on the pressure wave dynamics of a vapour-liquid two-phase medium of bubble and slug structure. The role of destruction and collapse of bubbles and slugs, phase transition (condensation and evaporation) on pressure wave dynamics is also studied. The general mechanisms of the wave formation, behavior and instability of a vapour-liquid structure under pressure waves, basic peculiarities of the interface heat transfer are obtained. In the experiments it has been shown that for the bubble medium the shock wave can be transformed into the powerful pressure pulse with an amplitude greater then the amplitude of the initial pressure wave. For the slug medium a characteristic structure of the amplificated wave is "comb" - like wave. It has been shown that the wave amplification caused by generation of secondary waves in a medium caused by destruction and collapse of bubbles and slugs. The obtained results can be useful at transient and emergency operational regimes of nuclear reactors, fuel tank, pipelines with two-phase flows and for development of safety models for chemical industry.

29666 (NUREG/CP--0142-Vol.2, pp. 1046-1068) **Evaluation of a main steam line break with induced, multiple tube ruptures: A comparison of NUREG 1477 (Draft) and transient methodologies Palo Verde Nuclear Generating Station.** Parrish, K.R. Nuclear Regulatory Commission, Washington, DC (United States). Div. of Systems Technology; American Nuclear Society, La Grange Park, IL (United States); American Inst. of Chemical Engineers, New York, NY (United States); American Society of Mechanical Engineers, New York, NY (United States); Canadian Nuclear Society, Toronto, ON (Canada); European Nuclear Society (ENS), Bern (Switzerland); Atomic Energy Society of Japan, Tokyo (Japan); Japan Society of Multiphase Flow, Kyoto (Japan). Sep 1995. (CONF-950904--Vol.2: 7. international meeting on nuclear reactor thermal hydraulics, Saratoga, NY (United States), 10-15 Sep 1995). In *Proceedings of the 7th International Meeting on Nuclear Reactor Thermal-Hydraulics NURETH-7. Volume 2, Sessions 6-11.* 795p. Source: OSTI; NTIS; INIS; GPO.

This paper presents the approach taken to analyze the radiological consequences of a postulated main steam line break event, with one or more tube ruptures, for the Palo Verde Nuclear Generating Station. The analysis was required to support the restart of PVNGS Unit 2 following the steam generator tube rupture event on March 14, 1993 and to justify continued operation of Units 1 and 3. During the post-event evaluation, the NRC expressed concern that Unit 2 could have been operating with degraded tubes and that similar conditions could exist in Units 1 and 3. The NRC therefore directed that a safety assessment be performed to evaluate a worst case scenario in which a non-isolable main steam line break occurs inducing one or more tube failures in the faulted steam generator. This assessment was to use the generic approach described in NUREG 1477, Voltage-Based Interim Plugging Criteria for Steam Generator Tubes - Task Group Report. An analysis based on the NUREG approach was performed but produced unacceptable results for off-site and control room thyroid doses. The NUREG methodology, however, does not account for plant thermal-hydraulic transient effects, system performance, or operator actions which could be credited to mitigate dose consequences. To deal with these issues, a more detailed analysis methodology was developed using a modified version of the Combustion Engineering Plant Analysis Code, which examines the dose consequences for a main steam line break transient with induced tube failures for a spectrum equivalent to 1 to 4 double ended guillotine U-tube breaks. By incorporating transient plant system responses and operator actions, the analysis demonstrates that the off-site and control room does consequences for a MSLBGTR can be reduced to acceptable limits. This analysis, in combination with other corrective and recovery actions, provided sufficient justification for continued operation of PVNGS Units 1 and 3, and for the subsequent restart of Unit 2.

29667 (NUREG/CP--0142-Vol.2, pp. 1069-1082) **Application of UPTF data for modeling liquid draindown in the downcomer region of a PWR using RELAP5/MOD2-B&W.** Wissinger, G. (B & W Nuclear Technologies, Lynchburg, VA (United States)); Klingenfus, J. Nuclear Regulatory Commission, Washington, DC (United States). Div. of Systems Technology; American Nuclear Society, La Grange Park, IL (United States); American Inst. of Chemical Engineers, New York, NY (United States); American Society of Mechanical Engineers, New York, NY (United States); Canadian Nuclear Society, Toronto, ON (Canada); European Nuclear Society (ENS), Bern (Switzerland); Atomic Energy Society of Japan, Tokyo (Japan); Japan Society of Multiphase Flow, Kyoto (Japan). Sep 1995. (CONF-950904--Vol.2: 7. international meeting on nuclear reactor thermal hydraulics, Saratoga, NY (United States), 10-15 Sep 1995). In *Proceedings of the 7th International Meeting on Nuclear Reactor Thermal-Hydraulics NURETH-7. Volume 2, Sessions 6-11.* 795p. Source: OSTI; NTIS; INIS; GPO.

B&W Nuclear Technologies (BWNT) currently uses an evaluation model that analyzes large break loss-of-coolant accidents in pressurized water reactors using several computer codes. These codes separately calculate the system performance during the blowdown, refill, and reflooding phases of the transient. Multiple codes are used, in part, because a single code has been unable to effectively model the transition from blowdown to reflood, particularly in the downcomer region where high steam velocities do not allow the injected emergency core cooling (ECC) liquid to penetrate and begin to refill the vessel lower plenum until after the end of blowdown. BWNT is developing a method using the RELAP5/MOD2-B&W computer code that can correctly predict the liquid draindown behavior in the downcomer during the late blowdown and refill phases. Benchmarks of this method have been performed against Upper Plenum Test Facility (UPTF) data for ECC liquid penetration and valves using both cold leg and downcomer ECC injection. The use of this new method in plant applications should result in the calculation of a shorter refill period, leading to lower peak clad temperature predictions and increased core peaking. This paper identifies changes made to the RELAP/MOD2-B&W code to improve its predictive capabilities with respect to the data obtained in the UPTF tests.

29668 (NUREG/CP--0142-Vol.2, pp. 1083-1089) **Plant data comparisons for Comanche Peak 1/2 main feedwater pump trip transient.** Boatwright, W.J. (TU Electric, Dallas, TX (United States)); Choe, W.G; Hiltbrand, D.W. Nuclear Regulatory Commission, Washington, DC (United States). Div. of Systems Technology; American Nuclear Society, La Grange Park, IL (United States); American Inst. of Chemical Engineers, New York, NY (United States); American Society of Mechanical Engineers, New York, NY (United States); Canadian Nuclear Society, Toronto, ON (Canada); European Nuclear Society (ENS), Bern (Switzerland); Atomic Energy Society of Japan, Tokyo (Japan); Japan Society of Multiphase Flow, Kyoto (Japan). Sep 1995. (CONF-950904--Vol.2: 7. international meeting on nuclear reactor thermal hydraulics, Saratoga, NY (United States), 10-15 Sep 1995). In *Proceedings of the 7th International Meeting on Nuclear Reactor Thermal-Hydraulics NURETH-7. Volume 2, Sessions 6-11.* 795p. Source: OSTI; NTIS; INIS; GPO.

A RETRAN-02 MOD5 model of Comanche Peak Steam Electric Station was developed by TU Electric for the purpose of performing core reload safety analyses. In order to qualify this model, comparisons against plant transient data from a partial loss of main feedwater flow were performed. These comparisons demonstrated that good representations of the plant response could be obtained with RETRAN-02 and the user-developed models of the primary-to-secondary heat transfer and plant control systems.

29669 (NUREG/CP--0142-Vol.2, pp. 1090-1099) **RBMK-LOCA-Analyses with the ATHLET-Code.** Petry, A. (Gesellschaft fuer Anlagen- und Reaktorsicherheit (GRS) mbH Kurfuerstendamm, Berlin (Germany)); Domoradov, A.; Finjakin, A. Nuclear

Regulatory Commission, Washington, DC (United States). Div. of Systems Technology; American Nuclear Society, La Grange Park, IL (United States); American Inst. of Chemical Engineers, New York, NY (United States); American Society of Mechanical Engineers, New York, NY (United States); Canadian Nuclear Society, Toronto, ON (Canada); European Nuclear Society (ENS), Bern (Switzerland); Atomic Energy Society of Japan, Tokyo (Japan); Japan Society of Multiphase Flow, Kyoto (Japan). Sep 1995. (CONF-950904–Vol.2: 7. international meeting on nuclear reactor thermal hydraulics, Saratoga, NY (United States), 10-15 Sep 1995). In *Proceedings of the 7th International Meeting on Nuclear Reactor Thermal-Hydraulics NURETH-7. Volume 2, Sessions 6-11.* 795p. Source: OSTI; NTIS; INIS; GPO.

The scientific technical cooperation between Germany and Russia includes the area of adaptation of several German codes for the Russian-designed RBMK-reactor. One point of this cooperation is the adaptation of the Thermal-Hydraulic code ATHLET (Analyses of the Thermal-Hydraulics of LEaks and Transients), for RBMK-specific safety problems. This paper contains a short description of a RBMK-1000 reactor circuit. Furthermore, the main features of the thermal-hydraulic code ATHLET are presented. The main assumptions for the ATHLET-RBMK model are discussed. As an example for the application, the results of test calculations concerning a guillotine type rupture of a distribution group header are presented and discussed, and the general analysis conditions are described. A comparison with corresponding RELAP-calculations is given. This paper gives an overview on some problems posed and experience by application of Western best-estimate codes for RBMK-calculations.

29670 (NUREG/CP–0142-Vol.2, pp. 1100-1115) **Small-break loss-of-coolant accidents in the updated PIUS 600 advanced reactor design.** Boyack, B.E. (Los Alamos National Lab., Albuquerque, NM (United States)); Steiner, J.L.; Harmony, S.C. Nuclear Regulatory Commission, Washington, DC (United States). Div. of Systems Technology; American Nuclear Society, La Grange Park, IL (United States); American Inst. of Chemical Engineers, New York, NY (United States); American Society of Mechanical Engineers, New York, NY (United States); Canadian Nuclear Society, Toronto, ON (Canada); European Nuclear Society (ENS), Bern (Switzerland); Atomic Energy Society of Japan, Tokyo (Japan); Japan Society of Multiphase Flow, Kyoto (Japan). Sep 1995. (CONF-950904–Vol.2: 7. international meeting on nuclear reactor thermal hydraulics, Saratoga, NY (United States), 10-15 Sep 1995). In *Proceedings of the 7th International Meeting on Nuclear Reactor Thermal-Hydraulics NURETH-7. Volume 2, Sessions 6-11.* 795p. Source: OSTI; NTIS; INIS; GPO.

The PIUS advanced reactor is a 640-MWe pressurized water reactor developed by Asea Brown Boveri (ABB). A unique feature of the PIUS concept is the absence of mechanical control and shutdown rods. Reactivity is normally controlled by coolant boron concentration and the temperature of the moderator coolant. ABB submitted the PIUS design to the US Nuclear Regulatory Commission (NRC) for preapplication review, and Los Alamos supported the NRC's review effort. Baseline analyses of small-break initiators at two locations were performed with the system neutronic and thermal-hydraulic analysis code TRAC-PF1/MOD2. In addition, sensitivity studies were performed to explore the robustness of the PIUS concept to severe off-normal conditions having a very low probability of occurrence.

29671 (NUREG/CP–0142-Vol.2, pp. 1116-1126) **Simulation of a beyond design-basis-accident with RELAP5/MOD3.1.** Banati, J. (Lappeenranta Univ. of Technology, Lappeenranta (Finland)). Nuclear Regulatory Commission, Washington, DC (United States). Div. of Systems Technology; American Nuclear Society, La Grange Park, IL (United States); American Inst. of Chemical Engineers, New York, NY (United States); American Society of Mechanical Engineers, New York, NY (United States); Canadian Nuclear Society, Toronto, ON (Canada); European Nuclear Society (ENS), Bern (Switzerland); Atomic Energy Society of Japan, Tokyo (Japan); Japan Society of Multiphase Flow, Kyoto (Japan). Sep 1995. (CONF-950904–Vol.2: 7. international meeting on nuclear reactor thermal hydraulics, Saratoga, NY (United States), 10-15 Sep 1995). In *Proceedings of the 7th International Meeting on Nuclear Reactor Thermal-Hydraulics NURETH-7. Volume 2, Sessions 6-11.* 795p. Source: OSTI; NTIS; INIS; GPO.

This paper summarizes the results of analyses, parametric and sensitivity studies, performed using the RELAP5/MOD3.1 computer code for the 4th IAEA Standard Problem Exercise (SPE-4). The test, conducted on the PMK-2 facility in Budapest, involved simulation of a Small Break Loss Of Coolant Accident (SBLOCA) with a 7.4% break in the cold leg of a VVER-440 type pressurized water reactor. According to the scenario, the unavailability of the high pressure injection system led to a beyond design basis accident. For prevention of core damage, secondary side bleed-and-feed accident management measures were applied. A brief description of the PMK-2 integral type test facility is presented, together with the profile and some key phenomenological aspects of this particular experiment. Emphasis is placed on the ability of the code to predict the main trends observed in the test and thus, an assessment is given for the code capabilities to represent the system transient.

29672 (NUREG/CP–0142-Vol.2, pp. 1127-1137) **Rapid depressurization event analysis in BWR/6 using RELAP5 and contain.** Mueftueoglu, A.K. (Pennsylvania State Univ., University Park, PA (United States)); Feltus, M.A. Nuclear Regulatory Commission, Washington, DC (United States). Div. of Systems Technology; American Nuclear Society, La Grange Park, IL (United States); American Inst. of Chemical Engineers, New York, NY (United States); American Society of Mechanical Engineers, New York, NY (United States); Canadian Nuclear Society, Toronto, ON (Canada); European Nuclear Society (ENS), Bern (Switzerland); Atomic Energy Society of Japan, Tokyo (Japan); Japan Society of Multiphase Flow, Kyoto (Japan). Sep 1995. Contract RS-NRR-93-027. (CONF-950904–Vol.2: 7. international meeting on nuclear reactor thermal hydraulics, Saratoga, NY (United States), 10-15 Sep 1995). In *Proceedings of the 7th International Meeting on Nuclear Reactor Thermal-Hydraulics NURETH-7. Volume 2, Sessions 6-11.* 795p. Source: OSTI; NTIS; INIS; GPO.

Noncondensable gases may become dissolved in Boiling Water Reactor (BWR) water level instrumentation during normal operations. Any dissolved noncondensable gases inside these water columns may come out of solution during rapid depressurization events, and displace water from the reference leg piping resulting in a false high level. These water level errors may cause a delay or failure in actuation, or premature shutdown of the Emergency Core Cooling System. (ECCS). If a rapid depressurization causes an erroneously high water level, preventing automatic ECCS actuation, it becomes important to determine if there would be other adequate indications for operator response and other signals for automatic actuation such as high drywell pressure. It is also important to determine the effect of the level signal on ECCS operation after it is being actuated. The objective of this study is to determine the detailed coupled containment/NSSS response during this rapid depressurization events in BWR/6. The selected scenarios involve: (a) inadvertent opening of all ADS valves, (b) design basis (DB) large break loss of coolant accident (LOCA), and (c) main steam line break (MSLB). The transient behaviors are evaluated in terms of: (a) vessel pressure and collapsed water level response, (b) specific transient boundary conditions, (e.g., scram, MSIV closure timing, feedwater flow, and break blowdown rates), (c) ECCS initiation timing, (d) impact of operator actions, (e) whether indications besides low-low water level were available. The results of the analysis had shown that there would be signals to actuate ECCS other than low reactor level, such as high drywell pressure, low vessel pressure, high suppression pool temperature, and that the plant operators would have significant indications to actuate ECCS.

29673 (NUREG/CP–0142-Vol.2, pp. 1139-1152) **A thermal-hydraulic code for transient analysis in a channel with a rod bundle.** Khodjaev, I.D. (Research & Engineering Centre of Nuclear Plants Safety, Electrogorsk (Russian Federation)). Nuclear Regulatory Commission, Washington, DC (United States). Div. of Systems Technology; American Nuclear Society, La Grange Park, IL (United States); American Inst. of Chemical Engineers, New York, NY (United States); American Society of Mechanical Engineers, New York, NY (United States); Canadian Nuclear Society, Toronto, ON (Canada); European Nuclear Society (ENS), Bern (Switzerland); Atomic Energy Society of Japan, Tokyo (Japan); Japan Society of

Multiphase Flow, Kyoto (Japan). Sep 1995. (CONF-950904–Vol.2: 7. international meeting on nuclear reactor thermal hydraulics, Saratoga, NY (United States), 10-15 Sep 1995). In *Proceedings of the 7th International Meeting on Nuclear Reactor Thermal-Hydraulics NURETH-7. Volume 2, Sessions 6-11.* 795p. Source: OSTI; NTIS; INIS; GPO.

The paper contains the model of transient vapor-liquid flow in a channel with a rod bundle of core of a nuclear power plant. The computer code has been developed to predict dryout and post-dryout heat transfer in rod bundles of nuclear reactor core under loss-of-coolant accidents. Economizer, bubble, dispersed-annular and dispersed regimes are taken into account. The computer code provides a three-field representation of two-phase flow in the dispersed-annular regime. Continuous vapor, continuous liquid film and entrained liquid drops are three fields. For the description of dispersed flow regime two-temperatures and single-velocity model is used. Relative droplet motion is taken into account for the droplet-to-vapor heat transfer. The conservation equations for each of regimes are solved using an effective numerical technique. This technique makes it possible to determine distribution of the parameters of flows along the perimeter of fuel elements. Comparison of the calculated results with the experimental data shows that the computer code adequately describes complex processes in a channel with a rod bundle during accident.

29674 (NUREG/CP–0142-Vol.2, pp. 1153-1168) **Analysis of an AP600 intermediate-size loss-of-coolant accident.** Boyack, B.E. (Los Alamos National Lab., NM (United States)); Lime, J.F. Nuclear Regulatory Commission, Washington, DC (United States). Div. of Systems Technology; American Nuclear Society, La Grange Park, IL (United States); American Inst. of Chemical Engineers, New York, NY (United States); American Society of Mechanical Engineers, New York, NY (United States); Canadian Nuclear Society, Toronto, ON (Canada); European Nuclear Society (ENS), Bern (Switzerland); Atomic Energy Society of Japan, Tokyo (Japan); Japan Society of Multiphase Flow, Kyoto (Japan). Sep 1995. (CONF-950904–Vol.2: 7. international meeting on nuclear reactor thermal hydraulics, Saratoga, NY (United States), 10-15 Sep 1995). In *Proceedings of the 7th International Meeting on Nuclear Reactor Thermal-Hydraulics NURETH-7. Volume 2, Sessions 6-11.* 795p. Source: OSTI; NTIS; INIS; GPO.

A postulated double-ended guillotine break of an AP600 direct-vessel-injection line has been analyzed. This event is characterized as an intermediate-break loss-of-coolant accident. Most of the insights regarding the response of the AP600 safety systems to the postulated accident are derived from calculations preformed with the TRAC-PF1/MOD2 code. However, complementary insights derived from a scaled experiment conducted in the ROSA facility, as well as insights based upon calculations by other codes, are also presented. Based upon the calculated and experimental results, the AP600 will not experience a core heat up and will reach a safe shutdown state using only safety-class equipment. Only the early part of the long-term cooling period initiated by In-containment Refueling Water Storage Tank injection was evaluated. Thus, the observation that the core is continuously cooled should be verified for the later phase of the long-term cooling period when sump injection and containment cooling processes are important.

29675 (NUREG/CP–0142-Vol.2, pp. 1169-1195) **A concept of JAERI passive safety light water reactor system (JPSR).** Murao, Y. (Japan Atomic Energy Research Institute, Tokai-mura (Japan)); Araya, F.; Iwamura, T. Nuclear Regulatory Commission, Washington, DC (United States). Div. of Systems Technology; American Nuclear Society, La Grange Park, IL (United States); American Inst. of Chemical Engineers, New York, NY (United States); American Society of Mechanical Engineers, New York, NY (United States); Canadian Nuclear Society, Toronto, ON (Canada); European Nuclear Society (ENS), Bern (Switzerland); Atomic Energy Society of Japan, Tokyo (Japan); Japan Society of Multiphase Flow, Kyoto (Japan). Sep 1995. (CONF-950904–Vol.2: 7. international meeting on nuclear reactor thermal hydraulics, Saratoga, NY (United States), 10-15 Sep 1995). In *Proceedings of the 7th International Meeting on Nuclear Reactor Thermal-Hydraulics NURETH-7. Volume 2, Sessions 6-11.* 795p. Source: OSTI; NTIS; INIS; GPO.

The Japan Atomic Energy Research Institute (JAERI) proposed a passive safety reactor system concept, JPSR, which was developed for reducing manpower in operation and maintenance and influence of human errors on reactor safety. In the concept the system was extremely simplified. The inherent matching nature of core generation and heat removal rate within a small volume change of the primary coolant is introduced by eliminating chemical shim and adopting in-vessel control rod drive mechanism units, a low power density core and once-through steam generators. In order to simplify the system, a large pressurizer, canned pumps, passive engineered-safety-features-system (residual heat removal system and coolant injection system) are adopted and the total system can be significantly simplified. The residual heat removal system is completely passively actuated in non-LOCAs and is also used for depressurization of the primary coolant system to actuate accumulators in small break LOCAs and reactor shutdown cooling system in normal operation. All of systems for nuclear steam supply system are built in the containment except for the air coolers as a the final heat sink of the passive residual heat removal system. Accordingly the reliability of the safety system and the normal operation system is improved, since most of residual heat removal system is always working and a heat sink for normal operation system is "safety class". In the passive coolant injection system, depressurization of the primary cooling system by residual heat removal system initiates injection from accumulators designed for the MS-600 in medium pressure and initiates injection from the gravity driven coolant injection pool at low pressure. Analysis with RETRAN-02/MOD3 code demonstrated the capability of passive load-following, self-power-controllability, cooling and depressurization.

29676 (NUREG/CP–0142-Vol.2, pp. 1196-1212) **Assessment of the advantages of a residual heat removal system inside the reactor pressure vessel.** Gautier, G.M. (Commissariat a l'Energie Atomique, Saint-Paul-Lez-Durance (France)). Nuclear Regulatory Commission, Washington, DC (United States). Div. of Systems Technology; American Nuclear Society, La Grange Park, IL (United States); American Inst. of Chemical Engineers, New York, NY (United States); American Society of Mechanical Engineers, New York, NY (United States); Canadian Nuclear Society, Toronto, ON (Canada); European Nuclear Society (ENS), Bern (Switzerland); Atomic Energy Society of Japan, Tokyo (Japan); Japan Society of Multiphase Flow, Kyoto (Japan). Sep 1995. (CONF-950904–Vol.2: 7. international meeting on nuclear reactor thermal hydraulics, Saratoga, NY (United States), 10-15 Sep 1995). In *Proceedings of the 7th International Meeting on Nuclear Reactor Thermal-Hydraulics NURETH-7. Volume 2, Sessions 6-11.* 795p. Source: OSTI; NTIS; INIS; GPO.

In the framework of research on diversified means for removing residual heat from pressurized water reactors, the CEA is studying a passive system called RRP (Refroidissement du Reacteur au Primaire, or primary circuit cooling system). This system consists of integrated heat-exchangers and a layout of the internal structures so as to obtain convection from the primary circuit inside the vessel, whatever the state of the loops. This system is operational for all primary circuit temperatures and pressures, as well as for a wide range of conditions: such as independent from the state of the loops, low volume of water in the primary circuit, compatibility with either a passive or an active operation mode, and compatibility with any other decay heat removal systems. This paper presents an evaluation of the performance of the RRP system in the event of a small primary circuit break in a totally passive operation mode without the intervention of any another system. The results of this evaluation show the potential interest of such a system: a clear increase of the time-delay for the implementation of a low pressure safety injection system and no need for the use of a high pressure safety injection system.

29677 (NUREG/CP–0142-Vol.2, pp. 1213-1223) **NRC review of passive reactor design certification testing programs: Overview, progress, and regulatory perspective.** Levin, A.E. Nuclear Regulatory Commission, Washington, DC (United States). Div. of Systems Technology; American Nuclear Society, La Grange Park, IL (United States); American Inst. of Chemical Engineers, New York, NY (United States); American Society of Mechanical Engineers, New York, NY (United States); Canadian Nuclear Society,

Toronto, ON (Canada); European Nuclear Society (ENS), Bern (Switzerland); Atomic Energy Society of Japan, Tokyo (Japan); Japan Society of Multiphase Flow, Kyoto (Japan). Sep 1995. (CONF-950904–Vol.2: 7. international meeting on nuclear reactor thermal hydraulics, Saratoga, NY (United States), 10-15 Sep 1995). In *Proceedings of the 7th International Meeting on Nuclear Reactor Thermal-Hydraulics NURETH-7. Volume 2, Sessions 6-11.* 795p. Source: OSTI; NTIS; INIS; GPO.

New reactor designs, employing passive safety systems, are currently under development by reactor vendors for certification under the U.S. Nuclear Regulatory Commission's (NRC's) design certification rule. The vendors have established testing programs to support the certification of the passive designs, to meet regulatory requirements for demonstration of passive safety system performance. The NRC has, therefore, developed a process for the review of the vendors' testing programs and for incorporation of the results of those reviews into the safety evaluations for the passive plants. This paper discusses progress in the test program reviews, and also addresses unique regulatory aspects of those reviews.

29678 (NUREG/CP–0142-Vol.2, pp. 1224-1248) **Flooding of a large, passive, pressure-tube LWR.** Hejzlar, P. (Massachusetts Institute of Technology, Cambridge, MA (United States)); Todreas, N.E.; Driscoll, M.J. Nuclear Regulatory Commission, Washington, DC (United States). Div. of Systems Technology; American Nuclear Society, La Grange Park, IL (United States); American Inst. of Chemical Engineers, New York, NY (United States); American Society of Mechanical Engineers, New York, NY (United States); Canadian Nuclear Society, Toronto, ON (Canada); European Nuclear Society (ENS), Bern (Switzerland); Atomic Energy Society of Japan, Tokyo (Japan); Japan Society of Multiphase Flow, Kyoto (Japan). Sep 1995. (CONF-950904–Vol.2: 7. international meeting on nuclear reactor thermal hydraulics, Saratoga, NY (United States), 10-15 Sep 1995). In *Proceedings of the 7th International Meeting on Nuclear Reactor Thermal-Hydraulics NURETH-7. Volume 2, Sessions 6-11.* 795p. Source: OSTI; NTIS; INIS; GPO.

A reactor concept has been developed which can survive LOCA without scram and without replenishing primary coolant inventory. The proposed concept is a pressure tube type reactor similar to CANDU reactors, but differing in three key aspects: (1) a solid SiC-coated graphite fuel matrix is used in place of fuel pin bundles, (2) the heavy water coolant in the pressure tubes is replaced by light water, and (3) the calandria tank contains a low pressure gas instead of heavy water moderator. The gas displaces the light water from the calandria during normal operation, while during loss of coolant or loss of heat sink accidents, it allows passive calandria flooding. This paper describes the thermal hydraulic characteristics of the gravity driven calandria flooding process. Flooding the calandria space with light water is a unique and very important feature of the proposed pressure-tube LWR concept. The flooding of the top row of fuel channels must be accomplished fast enough so that none of the critical components of the fuel channel exceed their design limits. The flooding process has been modeled and shown to be rapid enough to maintain all components within their design limits. Two other considerations are important. The thermal shock experienced by the calandria and pressure tubes has been evaluated and shown to be within acceptable bounds. Finally, although complete flooding renders the reactor deeply subcritical, various steam/water densities can be hypothesized to be present during the flooding process which could cause reactivity to increase from the initially voided calandria case. One such hypothesis which leads to the maximum possible density of the steam/water mixture in the still unflooded calandria space is entrainment from the free surface. It is shown that the steam/water mixture density yielding the maximum reactivity peak cannot be achieved by entrainment because it exceeds thermohydraulically attainable densities of steam/water by an order of magnitude.

29679 (NUREG/CP–0142-Vol.2, pp. 1249-1271) **SBWR PCCS vent phenomena and suppression pool mixing.** Coddington, P. (Thermal-Hydraulics Lab., Paul Scherrer Institute, Villigen (Switzerland)); Andreani, M. Nuclear Regulatory Commission, Washington, DC (United States). Div. of Systems Technology; American Nuclear Society, La Grange Park, IL (United States); American Inst. of Chemical Engineers, New York, NY (United States); American Society of Mechanical Engineers, New York, NY (United States); Canadian Nuclear Society, Toronto, ON (Canada); European Nuclear Society (ENS), Bern (Switzerland); Atomic Energy Society of Japan, Tokyo (Japan); Japan Society of Multiphase Flow, Kyoto (Japan). Sep 1995. Contract Nr. 514. (CONF-950904–Vol.2: 7. international meeting on nuclear reactor thermal hydraulics, Saratoga, NY (United States), 10-15 Sep 1995). In *Proceedings of the 7th International Meeting on Nuclear Reactor Thermal-Hydraulics NURETH-7. Volume 2, Sessions 6-11.* 795p. Source: OSTI; NTIS; INIS; GPO.

The most important phenomena influencing the effectiveness of the pressure suppression capability of the water pool within the Wetwell compartment of the SBWR Containment, during the period of Passive Containment Cooling System (PCCS) venting, have been critically reviewed. In addition, calculations have been carried-out to determine the condensation of the vented steam and the distribution of the energy deposited in the liquid pool. It has been found that a large contribution to the vapour suppression is due to condensation inside the vent pipe. The condensation rate of the steam inside the bubbles, produced at the vent exit, during their rise to the surface, may however be rather low, because of the large size bubbles. This can lead to vapour channelling to the Wetwell gas space. The above comments are likely to be ameliorated if the vent exit is a distributed source or sparger. Due to the large water flow rates within the "bubbly two-phase plume" generated by the gas injection, the water in the pool above the vent exit is likely to be heated nearly isothermally (perfect mixing). The effect of the suppression pool walls would be to enhance the recirculation and, consequently to promote mixing. The large size of the bubbles therein and of the walls on pool mixing are the most severe difficulties in extrapolating the results from scaled experiments to prototypical conditions.

29680 (NUREG/CP–0142-Vol.2, pp. 1272-1290) **Scaling for integral simulation of thermal-hydraulic phenomena in SBWR during LOCA.** Ishii, M. (Purdue Univ., West Layfayette, IN (United States)); Revankar, S.T.; Dowlati, R. Nuclear Regulatory Commission, Washington, DC (United States). Div. of Systems Technology; American Nuclear Society, La Grange Park, IL (United States); American Inst. of Chemical Engineers, New York, NY (United States); American Society of Mechanical Engineers, New York, NY (United States); Canadian Nuclear Society, Toronto, ON (Canada); European Nuclear Society (ENS), Bern (Switzerland); Atomic Energy Society of Japan, Tokyo (Japan); Japan Society of Multiphase Flow, Kyoto (Japan). Sep 1995. (CONF-950904–Vol.2: 7. international meeting on nuclear reactor thermal hydraulics, Saratoga, NY (United States), 10-15 Sep 1995). In *Proceedings of the 7th International Meeting on Nuclear Reactor Thermal-Hydraulics NURETH-7. Volume 2, Sessions 6-11.* 795p. Source: OSTI; NTIS; INIS; GPO.

A scaling study has been conducted for simulation of thermal-hydraulic phenomena in the Simplified Boiling Water Reactor (SBWR) during a loss of coolant accident. The scaling method consists of a three-level scaling approach. The integral system scaling (global scaling or top down approach) consists of two levels, the integral response function scaling which forms the first level, and the control volume and boundary flow scaling which forms the second level. The bottom up approach is carried out by local phenomena scaling which forms the third level scaling. Based on this scaling study the design of the model facility called Purdue University Multi-Dimensional Integral Test Assembly (PUMA) has been carried out. The PUMA facility has 1/4 height and 1/100 area ratio scaling, corresponding to the volume scaling of 1/400. The PUMA power scaling based on the integral scaling is 1/200. The present scaling method predicts that PUMA time scale will be one-half that of the SBWR. The system pressure for PUMA is full scale, therefore, a prototypic pressure is maintained. PUMA is designed to operate at and below 1.03 MPa (150 psi), which allows it to simulate the prototypic SBWR accident conditions below 1.03 MPa (150 psi). The facility includes models for all components of importance.

29681 (NUREG/CP–0142-Vol.2, pp. 1291-1301) **A practical view of the insights from scaling thermal-hydraulic tests.** Levin,

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The authors review the broad concept of scaling of thermal-hydraulic test facilities designed to acquire data for application to modeling the behavior of nuclear power plants, especially as applied to the design certification of passive advanced light water reactors. Distortions and uncertainties in the scaling process are described, and the possible impact of these effects on the test data are discussed. A practical approach to the use of data from the facilities is proposed, with emphasis on the insights to be gained from the test results rather than direct application of test results to behavior of a large plant.

29682 (NUREG/CP–0142-Vol.2, pp. 1302-1312) **Analysis of overflow-induced sloshing in an elestic-wall vessel using physical component BFC method.** Lu, D. (Univ. of Tokyo (Japan)); Kondo, S.; Takizawa, A. Nuclear Regulatory Commission, Washington, DC (United States). Div. of Systems Technology; American Nuclear Society, La Grange Park, IL (United States); American Inst. of Chemical Engineers, New York, NY (United States); American Society of Mechanical Engineers, New York, NY (United States); Canadian Nuclear Society, Toronto, ON (Canada); European Nuclear Society (ENS), Bern (Switzerland); Atomic Energy Society of Japan, Tokyo (Japan); Japan Society of Multiphase Flow, Kyoto (Japan). Sep 1995. (CONF-950904–Vol.2: 7. international meeting on nuclear reactor thermal hydraulics, Saratoga, NY (United States), 10-15 Sep 1995). In *Proceedings of the 7th International Meeting on Nuclear Reactor Thermal-Hydraulics NURETH-7. Volume 2, Sessions 6-11.* 795p. Source: OSTI; NTIS; INIS; GPO.

Newly developed "physical component boundary fitted coordinate (PCBFC) method" is applied to the fluid-structure interaction problems. The applicability was verified through several benchmark problems. Then, 2D experiment on overflow-induced fluid-structure interaction instability was simulated. The computation showed occurrence scope of instability essentially the same as that obtained by experiment. By computations with modified initial and boundary conditions, several basic factors for the occurrence of this instability were obtained.

29683 (NUREG/CP–0142-Vol.2, pp. 1313-1323) **Study on mixed convective flow penetration into subassembly from reactor hot plenum in FBRs.** Kobayashi, J. (Power Reactor and Nuclear Fuel Development Corporation, Ibaraki (Japan)); Ohshima, H.; Kamide, H.; Ieda, Y. Nuclear Regulatory Commission, Washington, DC (United States). Div. of Systems Technology; American Nuclear Society, La Grange Park, IL (United States); American Inst. of Chemical Engineers, New York, NY (United States); American Society of Mechanical Engineers, New York, NY (United States); Canadian Nuclear Society, Toronto, ON (Canada); European Nuclear Society (ENS), Bern (Switzerland); Atomic Energy Society of Japan, Tokyo (Japan); Japan Society of Multiphase Flow, Kyoto (Japan). Sep 1995. (CONF-950904–Vol.2: 7. international meeting on nuclear reactor thermal hydraulics, Saratoga, NY (United States), 10-15 Sep 1995). In *Proceedings of the 7th International Meeting on Nuclear Reactor Thermal-Hydraulics NURETH-7. Volume 2, Sessions 6-11.* 795p. Source: OSTI; NTIS; INIS; GPO.

Fundamental experiments using water were carried out in order to reveal the phenomenon of mixed convective flow penetration into subassemblies from a reactor's upper plenum of fast breeder reactors. This phenomenon appears under a certain natural circulation conditions during the operation of the direct reactor auxiliary cooling system for decay heat removal and might influence the natural circulation head which determines the core flow rate and therefore affects the core coolability. In the experiment, a simplified model which simulates an upper plenum and a subassembly was used and the ultrasonic velocity profile monitor as well as thermocouples were applied for the simultaneous measurement of velocity and temperature distributions in the subassembly. From the measured data, empirical equations related to the penetration flow onset condition and the penetration depth were obtained using relevant parameters which were derived from dimensional analysis.

29684 (NUREG/CP–0142-Vol.2, pp. 1324-13332) **Large eddy simulation of mixing between hot and cold sodium flows - comparison with experiments.** Simoneau, J.P.; Noe, H.; Menant, B. Nuclear Regulatory Commission, Washington, DC (United States). Div. of Systems Technology; American Nuclear Society, La Grange Park, IL (United States); American Inst. of Chemical Engineers, New York, NY (United States); American Society of Mechanical Engineers, New York, NY (United States); Canadian Nuclear Society, Toronto, ON (Canada); European Nuclear Society (ENS), Bern (Switzerland); Atomic Energy Society of Japan, Tokyo (Japan); Japan Society of Multiphase Flow, Kyoto (Japan). Sep 1995. (CONF-950904–Vol.2: 7. international meeting on nuclear reactor thermal hydraulics, Saratoga, NY (United States), 10-15 Sep 1995). In *Proceedings of the 7th International Meeting on Nuclear Reactor Thermal-Hydraulics NURETH-7. Volume 2, Sessions 6-11.* 795p. Source: OSTI; NTIS; INIS; GPO.

The large eddy simulation is becoming a potential powerful tool for the calculation of turbulent flows. In nuclear liquid metal cooled fast reactors, the knowledge of the turbulence characteristics is of great interest for the prediction and the analysis of thermal stripping phenomena. The objective of this paper is to give a contribution in the evaluation of the large eddy simulation technique is an individual case. The problem chosen is the case of the mixing between hot and cold sodium flows. The computations are compared with available sodium tests. This study shows acceptable qualitative results but the simple model used is not able to predict the turbulence characteristics. More complex models including larger domains around the fluctuating zone and fluctuating boundary conditions could be necessary. Validation works are continuing.

29685 (NUREG/CP–0142-Vol.2, pp. 1333-1350) **Natural convection heat transfer on two horizontal cylinders in liquid sodium.** Hata, K. (Institute of Atomic Energy, Kyoto Univ. (Japan)); Shiotsu, M.; Takeuchi, Y. Nuclear Regulatory Commission, Washington, DC (United States). Div. of Systems Technology; American Nuclear Society, La Grange Park, IL (United States); American Inst. of Chemical Engineers, New York, NY (United States); American Society of Mechanical Engineers, New York, NY (United States); Canadian Nuclear Society, Toronto, ON (Canada); European Nuclear Society (ENS), Bern (Switzerland); Atomic Energy Society of Japan, Tokyo (Japan); Japan Society of Multiphase Flow, Kyoto (Japan). Sep 1995. (CONF-950904–Vol.2: 7. international meeting on nuclear reactor thermal hydraulics, Saratoga, NY (United States), 10-15 Sep 1995). In *Proceedings of the 7th International Meeting on Nuclear Reactor Thermal-Hydraulics NURETH-7. Volume 2, Sessions 6-11.* 795p. Source: OSTI; NTIS; INIS; GPO.

Natural convection heat transfer on two horizontal 7.6 mm diameter test cylinders assembled with the ratio of the distance between each cylinder axis to the cylinder diameter, S/D, of 2 in liquid sodium was studied experimentally and theoretically. The heat transfer coefficients on the cylinder surface due to the same heat inputs ranging from 1.0×10^7 to 1.0×10^9 W/m^3 were obtained experimentally for various setting angeles, γ, between vertical direction and the plane including both of these cylinder axis over the range of zero to 90°. Theoretical equations for laminar natural convection heat transfer from the two horizontal cylinders were numerically solved for the same conditions as the experimental ones considering the temperature dependence of thermophysical properties concerned. The average Nusselt numbers, Nu, values on the Nu versus modified Rayleigh number, R_f, graph. The experimental values of Nu for the upper cylinder are about 20% lower than those for the lower cylinder at $\gamma = 0°$ for the range of R_f tested here. The value of Nu for the upper cylinder becomes higher and approaches that for the lower cylinder with the increase in γ over range of 0 to 90°. The values of Nu for the lower cylinder at each γ are almost in agreement with those for a single cylinder. The

theoretical values of Nu on two cylinders except those for $R_f<4$ at $\gamma = 0°$ are in agreement with the experimental data at each γ with the deviations less than 15%. Correlations for Nu on the upper and lower cylinders were obtained as functions of S/D and γ based n the theoretical solutions for the S/D ranged over 1.5 to 4.0.

29686 (NUREG/CP–0142-Vol.2, pp. 1351-1360) **Evaluation of wrapper tube temperatures of fast neutron reactors using the TRANSCOEUR-2 code.** Valentin, B. (CEA/DRN/DEC/SECA/LHC CEN, St Paul Lez Durance (France)); Brun P.; Chaigne, G. Nuclear Regulatory Commission, Washington, DC (United States). Div. of Systems Technology; American Nuclear Society, La Grange Park, IL (United States); American Inst. of Chemical Engineers, New York, NY (United States); American Society of Mechanical Engineers, New York, NY (United States); Canadian Nuclear Society, Toronto, ON (Canada); European Nuclear Society (ENS), Bern (Switzerland); Atomic Energy Society of Japan, Tokyo (Japan); Japan Society of Multiphase Flow, Kyoto (Japan). Sep 1995. (CONF-950904–Vol.2: 7. international meeting on nuclear reactor thermal hydraulics, Saratoga, NY (United States), 10-15 Sep 1995). In *Proceedings of the 7th International Meeting on Nuclear Reactor Thermal-Hydraulics NURETH-7. Volume 2, Sessions 6-11.* 795p. Source: OSTI; NTIS; INIS; GPO.

This paper deals with the thermal loading estimation of wrapper tubes using the TRANSCOEUR-2 code. This estimation requires a knowledge of two temperature fields: the first involves the peripheral sub-channel temperatures of each sub-assembly calculated by the design code CADET, and the second, outside the sub-assemblies, is the inter-wrapper flow temperature field calculated by the thermal-hydraulic code TRIO-VF with boundary conditions taken from CADET. Theoretical models of the three codes are presented as well as the first TRANSCOEUR-2 wrapper tube temperature calculation performed on the European Fast Reactor (EFR) Core Design 6/91 (CD 6/91) under nominal power conditions. The results show a temperature variation of 115°C between the bottom of the lower blanket and the top of the upper blanket fuel sub-assemblies in the center of the core and 95°C at the core periphery. The wrapper tube temperatures are higher in the center than in the external core.

29687 (NUREG/CP–0142-Vol.2, pp. 1361-1379) **Simulation of decay heat removal by natural convection in a pool type fast reactor model-ramona-with coupled 1D/2D thermal hydraulic code system.** Kasinathan, N. (Indira Gandhi Centre for Atomic Research, Kalpakkam (India)); Rajakumar, A.; Vaidyanathan, G.; Chetal, S.C. Nuclear Regulatory Commission, Washington, DC (United States). Div. of Systems Technology; American Nuclear Society, La Grange Park, IL (United States); American Inst. of Chemical Engineers, New York, NY (United States); American Society of Mechanical Engineers, New York, NY (United States); Canadian Nuclear Society, Toronto, ON (Canada); European Nuclear Society (ENS), Bern (Switzerland); Atomic Energy Society of Japan, Tokyo (Japan); Japan Society of Multiphase Flow, Kyoto (Japan). Sep 1995. (CONF-950904–Vol.2: 7. international meeting on nuclear reactor thermal hydraulics, Saratoga, NY (United States), 10-15 Sep 1995). In *Proceedings of the 7th International Meeting on Nuclear Reactor Thermal-Hydraulics NURETH-7. Volume 2, Sessions 6-11.* 795p. Source: OSTI; NTIS; INIS; GPO.

Post shutdown decay heat removal is an important safety requirement in any nuclear system. In order to improve the reliability of this function, Liquid metal (sodium) cooled fast breeder reactors (LMFBR) are equipped with redundant hot pool dipped immersion coolers connected to natural draught air cooled heat exchangers through intermediate sodium circuits. During decay heat removal, flow through the core, immersion cooler primary side and in the intermediate sodium circuits are also through natural convection. In order to establish the viability and validate computer codes used in making predictions, a 1:20 scale experimental model called RAMONA with water as coolant has been built and experimental simulation of decay heat removal situation has been performed at KfK Karlsruhe. Results of two such experiments have been compiled and published as benchmarks. This paper brings out the results of the numerical simulation of one of the benchmark case through a 1D/2D coupled code system, DHDYN-1D/THYC-2D and the salient features of the comparisons. Brief description of the formulations of the codes are also included.

29688 (NUREG/CP–0142-Vol.2, pp. 1380-1397) **Conjugate heat transfer analysis of multiple enclosures in prototype fast breeder reactor.** Velusamy, K. (Indira Gandhi Centre for Atomic Research, Kalpakkam (India)); Balaubramanian, V.; Vaidyanathan, G.; Chetal, S.C. Nuclear Regulatory Commission, Washington, DC (United States). Div. of Systems Technology; American Nuclear Society, La Grange Park, IL (United States); American Inst. of Chemical Engineers, New York, NY (United States); American Society of Mechanical Engineers, New York, NY (United States); Canadian Nuclear Society, Toronto, ON (Canada); European Nuclear Society (ENS), Bern (Switzerland); Atomic Energy Society of Japan, Tokyo (Japan); Japan Society of Multiphase Flow, Kyoto (Japan). Sep 1995. (CONF-950904–Vol.2: 7. international meeting on nuclear reactor thermal hydraulics, Saratoga, NY (United States), 10-15 Sep 1995). In *Proceedings of the 7th International Meeting on Nuclear Reactor Thermal-Hydraulics NURETH-7. Volume 2, Sessions 6-11.* 795p. Source: OSTI; NTIS; INIS; GPO.

Prototype Fast Breeder Reactor (PFBR) is a 500 MWe sodium cooled reactor under design. The main vessel of the reactor serves as the primary boundary. It is surrounded by a safety vessel which in turn is surrounded by biological shield. The gaps between them are filled with nitrogen. Knowledge of temperature distribution prevailing under various operating conditions is essential for the assessment of structural integrity. Due to the presence of cover gas over sodium free level within the main vessel, there are sharp gradients in temperatures. Also cover gas height reduces during station blackout conditions due to sodium level rise in main vessel caused by temperature rise. This paper describes the model used to analyse the natural convection in nitrogen, conduction in structures and radiation interaction among them. Results obtained from parametric studies for PFBR are also presented.

29689 (NUREG/CP–0142-Vol.2, pp. 1398-1406) **Computational modeling for hexcan failure under core distruptive accidental conditions.** Sawada, T. (Tokyo Institute of Technology (Japan)); Ninokata, H.; Shimizu, A. Nuclear Regulatory Commission, Washington, DC (United States). Div. of Systems Technology; American Nuclear Society, La Grange Park, IL (United States); American Inst. of Chemical Engineers, New York, NY (United States); American Society of Mechanical Engineers, New York, NY (United States); Canadian Nuclear Society, Toronto, ON (Canada); European Nuclear Society (ENS), Bern (Switzerland); Atomic Energy Society of Japan, Tokyo (Japan); Japan Society of Multiphase Flow, Kyoto (Japan). Sep 1995. (CONF-950904–Vol.2: 7. international meeting on nuclear reactor thermal hydraulics, Saratoga, NY (United States), 10-15 Sep 1995). In *Proceedings of the 7th International Meeting on Nuclear Reactor Thermal-Hydraulics NURETH-7. Volume 2, Sessions 6-11.* 795p. Source: OSTI; NTIS; INIS; GPO.

This paper describes the development of computational modeling for hexcan wall failures under core disruptive accident conditions of fast breeder reactors. A series of out-of-pile experiments named SIMBATH has been analyzed by using the SIMMER-II code. The SIMBATH experiments were performed at KfK in Germany. The experiments used a thermite mixture to simulate fuel. The test geometry of SIMBATH ranged from single pin to 37-pin bundles. In this study, phenomena of hexcan wall failure found in a SIMBATH test were analyzed by SIMMER-II. Although the original model of SIMMER-II did not calculate any hexcan failure, several simple modifications made it possible to reproduce the hexcan wall melt-through observed in the experiment. In this paper the modifications and their significance are discussed for further modeling improvements.

29690 (NUREG/CP–0142-Vol.2, pp. 1407-1417) **Investigations on sump cooling after core melt down.** Knebel, J.U. (Forschungeszentrum Karlsruhe - Technik und Umwelt Institut fuer Angewandte Thermo- und Fluiddynamik, Karlsruhe (Germany)). Nuclear Regulatory Commission, Washington, DC (United States). Div. of Systems Technology; American Nuclear Society, La Grange Park, IL (United States); American Inst. of Chemical Engineers, New York, NY (United States); American Society of Mechanical Engineers, New York, NY (United States); Canadian Nuclear Society,

Toronto, ON (Canada); European Nuclear Society (ENS), Bern (Switzerland); Atomic Energy Society of Japan, Tokyo (Japan); Japan Society of Multiphase Flow, Kyoto (Japan). Sep 1995. (CONF-950904–Vol.2: 7. international meeting on nuclear reactor thermal hydraulics, Saratoga, NY (United States), 10-15 Sep 1995). In *Proceedings of the 7th International Meeting on Nuclear Reactor Thermal-Hydraulics NURETH-7. Volume 2, Sessions 6-11.* 795p. Source: OSTI; NTIS; INIS; GPO.

This article presents the basic physical phenomena and scaling criteria of decay heat removal from a large coolant pool by single-phase and two-phase natural circulation flow. The physical significance of the dimensionless similarity groups derived is evaluated. The above results are applied to the SUCO program that is performed at the Forschungszentrum Karlsruhe. The SUCO program is a three-step series of scaled model experiments investigating the possibility of an optional sump cooling concept for the European Pressurized Water Reactor EPR. This concept is entirely based on passive safety features within the containment. The work is supported by the German utilities and the Siemens dimensional SUCOS-2D test facility. The experimental results of the model geometry are transformed to prototypic conditions.

29691 (NUREG/CP–0142-Vol.2, pp. 1418-1442) **Containment atmosphere response to external sprays.** Green, J. (Univ. of Maryland, College Park, MD (United States)); Almenas, K. Nuclear Regulatory Commission, Washington, DC (United States). Div. of Systems Technology; American Nuclear Society, La Grange Park, IL (United States); American Inst. of Chemical Engineers, New York, NY (United States); American Society of Mechanical Engineers, New York, NY (United States); Canadian Nuclear Society, Toronto, ON (Canada); European Nuclear Society (ENS), Bern (Switzerland); Atomic Energy Society of Japan, Tokyo (Japan); Japan Society of Multiphase Flow, Kyoto (Japan). Sep 1995. Contract NRC-04-91-062. (CONF-950904–Vol.2: 7. international meeting on nuclear reactor thermal hydraulics, Saratoga, NY (United States), 10-15 Sep 1995). In *Proceedings of the 7th International Meeting on Nuclear Reactor Thermal-Hydraulics NURETH-7. Volume 2, Sessions 6-11.* 795p. Source: OSTI; NTIS; INIS; GPO.

The application of external sprays to a containment steel shell can be an effective energy removal method and has been proposed in the passive AP-600 design. Reduction of the steel shell temperature in contact with the containment atmosphere enhances both heat and mass transfer driving forces. Large scale experimental data in this area is scarce, therefore the measurements obtained from the E series tests conducted at the German HDR facility deserve special attention. These long term tests simulated various severe accident conditions, including external spraying of the hemispherical steel shell. This investigation focuses upon the integral response of the HDR containment atmosphere during spray periods and upon methods by which lumped parameter system codes, like CONTAIN, model the underlying condensation phenomena. Increases in spray water flowrates above a minimum value were ineffective at improving containment pressure reduction since the limiting resistance for energy transfer lies in the noncondensable-vapor boundary layer at the inner condensing surface. The spray created an unstable condition by cooling the upper layers of a heated atmosphere and thus inducing global natural circulation flows in the facility and subsequently, abrupt changes in lighter-than-air noncondensable (J_2/He) concentrations. Modeling results using the CONTAIN code are outlined and code limitations are delineated.

29692 (NUREG/CP–0142-Vol.2, pp. 1443-1455) **Modeling of local steam condensation on walls in presence of noncondensable gases. Application to a loca calculation in reactor containment using the multidimensional geyser/tonus code.** Benet, L.V. (Commissariat a l'Energie Atomique, Gif sur Yvette (France)); Caroli, C.; Cornet, P. Nuclear Regulatory Commission, Washington, DC (United States). Div. of Systems Technology; American Nuclear Society, La Grange Park, IL (United States); American Inst. of Chemical Engineers, New York, NY (United States); American Society of Mechanical Engineers, New York, NY (United States); Canadian Nuclear Society, Toronto, ON (Canada); European Nuclear Society (ENS), Bern (Switzerland); Atomic Energy Society of Japan, Tokyo (Japan); Japan Society of Multiphase Flow, Kyoto (Japan). Sep 1995. (CONF-950904–Vol.2: 7. international meeting on nuclear reactor thermal hydraulics, Saratoga, NY (United States), 10-15 Sep 1995). In *Proceedings of the 7th International Meeting on Nuclear Reactor Thermal-Hydraulics NURETH-7. Volume 2, Sessions 6-11.* 795p. Source: OSTI; NTIS; INIS; GPO.

This paper reports part of a study of possible severe pressurized water reactor (PWR) accidents. The need for containment modeling, and in particular for a hydrogen risk study, was reinforced in France after 1990, with the requirement that severe accidents must be taken into account in the design of future plants. This new need of assessing the transient local hydrogen concentration led to the development, in the Mechanical Engineering and Technology Department of the French Atomic Energy Commission (CEA/DMT), of the multidimensional code GEYSER/TONUS for containment analysis. A detailed example of the use of this code is presented. The mixture consisted of noncondensable gases (air or air plus hydrogen) and water vapor and liquid water. This is described by a compressible homogeneous two-phase flow model and wall condensation is based on the Chilton-Colburn formula and the analogy between heat and mass transfer. Results are given for a transient two-dimensional axially-symmetric computation for the first hour of a simplified accident sequence. In this there was an initial injection of a large amount of water vapor followed by a smaller amount and by hydrogen injection.

29693 (NUREG/CP–0142-Vol.2, pp. 1456-1476) **The modelling of wall condensation with noncondensable gases for the containment codes.** Leduc, C. (Commissariat a l'Energi Atomique, Grenoble (France)); Coste, P.; Barthel, V.; Deslandes, H. Nuclear Regulatory Commission, Washington, DC (United States). Div. of Systems Technology; American Nuclear Society, La Grange Park, IL (United States); American Inst. of Chemical Engineers, New York, NY (United States); American Society of Mechanical Engineers, New York, NY (United States); Canadian Nuclear Society, Toronto, ON (Canada); European Nuclear Society (ENS), Bern (Switzerland); Atomic Energy Society of Japan, Tokyo (Japan); Japan Society of Multiphase Flow, Kyoto (Japan). Sep 1995. (CONF-950904–Vol.2: 7. international meeting on nuclear reactor thermal hydraulics, Saratoga, NY (United States), 10-15 Sep 1995). In *Proceedings of the 7th International Meeting on Nuclear Reactor Thermal-Hydraulics NURETH-7. Volume 2, Sessions 6-11.* 795p. Source: OSTI; NTIS; INIS; GPO.

This paper presents several approaches in the modelling of wall condensation in the presence of noncondensable gases for containment codes. The lumped-parameter modelling and the local modelling by 3-D codes are discussed. Containment analysis codes should be able to predict the spatial distributions of steam, air, and hydrogen as well as the efficiency of cooling by wall condensation in both natural convection and forced convection situations. 3-D calculations with a turbulent diffusion modelling are necessary since the diffusion controls the local condensation whereas the wall condensation may redistribute the air and hydrogen mass in the containment. A fine mesh modelling of film condensation in forced convection has been in the developed taking into account the influence of the suction velocity at the liquid-gas interface. It is associated with the 3-D model of the TRIO code for the gas mixture where a k-ξ turbulence model is used. The predictions are compared to the Huhtiniemi's experimental data. The modelling of condensation in natural convection or mixed convection is more complex. As no universal velocity and temperature profile exist for such boundary layers, a very fine nodalization is necessary. More simple models integrate equations over the boundary layer thickness, using the heat and mass transfer analogy. The model predictions are compared with a MIT experiment. For the containment compartments a two node model is proposed using the lumped parameter approach. Heat and mass transfer coefficients are tested on separate effect tests and containment experiments. The CATHARE code has been adapted to perform such calculations and shows a reasonable agreement with data.

29694 (NUREG/CP–0142-Vol.2, pp. 1477-1488) **An interpretation of passive containment cooling phenomena.** Chung, Bum-Jin (Ministry of Science & Technology, Kyunggi-Do (Korea,

Democratic People's Republic of)); Kang, Chang-Sun,. Nuclear Regulatory Commission, Washington, DC (United States). Div. of Systems Technology; American Nuclear Society, La Grange Park, IL (United States); American Inst. of Chemical Engineers, New York, NY (United States); American Society of Mechanical Engineers, New York, NY (United States); Canadian Nuclear Society, Toronto, ON (Canada); European Nuclear Society (ENS), Bern (Switzerland); Atomic Energy Society of Japan, Tokyo (Japan); Japan Society of Multiphase Flow, Kyoto (Japan). Sep 1995. (CONF-950904--Vol.2: 7. international meeting on nuclear reactor thermal hydraulics, Saratoga, NY (United States), 10-15 Sep 1995). In *Proceedings of the 7th International Meeting on Nuclear Reactor Thermal-Hydraulics NURETH-7. Volume 2, Sessions 6-11.* 795p. Source: OSTI; NTIS; INIS; GPO.

A simplified interpretation model for the cooling capability of the Westinghouse type PCCS is proposed in this paper. The PCCS domain was phenomenologically divided into 3 regions; water entrance effect region, asymptotic region, and air entrance effect region. The phenomena in the asymptotic region is focused in this paper. Due to the very large height to thickness ratio of the water film, the length of the asymptotic region is estimated to be over 90% of the whole domain. Using the analogy between heat and mass transfer phenomena in a turbulent situation, a new dependent variable combining temperature and vapor mass fraction was defined. The similarity between the PCCS phenomena, which contains the sensible and latent heat transfer, and the buoyant air flow on a vertical heated plate is derived. The modified buoyant coefficient and thermal conductivity were defined. Using these newly defined variable and coefficients, the modified correlation for the interfacial heat fluxes and the ratios of latent heat transfer to sensible heat transfer is established. To verify the accuracy of the correlation, the results of this study were compared with the results of other numerical analyses performed for the same configuration and they are well within the range of 15% difference.

29695 (NUREG/CP--0142-Vol.2, pp. 1489-1500) **Detailed thermal-hydraulic computation into a containment building.** Caruso. A. (EDF/LNH, Chatou (France)); Flour, I.; Simonin, O.; Cherbonnel, C. Nuclear Regulatory Commission, Washington, DC (United States). Div. of Systems Technology; American Nuclear Society, La Grange Park, IL (United States); American Inst. of Chemical Engineers, New York, NY (United States); American Society of Mechanical Engineers, New York, NY (United States); Canadian Nuclear Society, Toronto, ON (Canada); European Nuclear Society (ENS), Bern (Switzerland); Atomic Energy Society of Japan, Tokyo (Japan); Japan Society of Multiphase Flow, Kyoto (Japan). Sep 1995. (CONF-950904--Vol.2: 7. international meeting on nuclear reactor thermal hydraulics, Saratoga, NY (United States), 10-15 Sep 1995). In *Proceedings of the 7th International Meeting on Nuclear Reactor Thermal-Hydraulics NURETH-7. Volume 2, Sessions 6-11.* 795p. Source: OSTI; NTIS; INIS; GPO.

This paper deals with numerical predictions of the influence of water sprays upon stratifications into a containment building using a two-dimensional two-phase flow code. Basic equations and closure assumptions are briefly presented. A test case in a situation involving spray evaporation is first detailed to illustrate the validation step. Then results are presented for a compressible recirculating flow into a containment building with condensation phenomena.

29696 (NUREG/CP--0142-Vol.2, pp. 1501-1518) **Free convective condensation in a vertical enclosure.** Fox, R.J. (Univ. of California, Berkeley, CA (United States)); Peterson, P.F.; Corradini, M.L.; Pernsteiner, A.P. Nuclear Regulatory Commission, Washington, DC (United States). Div. of Systems Technology; American Nuclear Society, La Grange Park, IL (United States); American Inst. of Chemical Engineers, New York, NY (United States); American Society of Mechanical Engineers, New York, NY (United States); Canadian Nuclear Society, Toronto, ON (Canada); European Nuclear Society (ENS), Bern (Switzerland); Atomic Energy Society of Japan, Tokyo (Japan); Japan Society of Multiphase Flow, Kyoto (Japan). Sep 1995. (CONF-950904--Vol.2: 7. international meeting on nuclear reactor thermal hydraulics, Saratoga, NY (United States), 10-15 Sep 1995). In *Proceedings of the 7th International Meeting on Nuclear Reactor Thermal-Hydraulics NURETH-7. Volume 2, Sessions 6-11.* 795p. Source: OSTI; NTIS; INIS; GPO.

Free convective condensation in a vertical enclosure was studied numerically and the results were compared with experiments. In both the numerical and experimental investigations, mist formation was observed to occur near the cooling wall, with significant droplet concentrations in the bulk. Large recirculation cells near the end of the condensing section were generated as the heavy non-condensing gas collecting near the cooling wall was accelerated downward. Near the top of the enclosure the recirculation cells became weaker and smaller than those below, ultimately disappearing near the top of the condenser. In the experiment the mist density was seen to be highest near the wall and at the bottom of the condensing section, whereas the numerical model predicted a much more uniform distribution. The model used to describe the formation of mist was based on a Modified Critical Saturation Model (MCSM), which allows mist to be generated once the vapor pressure exceeds a critical value. Equilibrium, nonequilibrium, and MCSM calculations were preformed, showing the experimental results to lie somewhere in between the equilibrium and nonequilibrium predictions of the numerical model. A single adjustable constant (indicating the degree to which equilibrium is achieved) is used in the model in order to match the experimental results.

29697 (NUREG/CP--0142-Vol.2, pp. 1519-1534) **Condensation in the presence of noncondensible gases: AP600 containment simulation.** Anderson, M.H.; Corradini, M.L. Nuclear Regulatory Commission, Washington, DC (United States). Div. of Systems Technology; American Nuclear Society, La Grange Park, IL (United States); American Inst. of Chemical Engineers, New York, NY (United States); American Society of Mechanical Engineers, New York, NY (United States); Canadian Nuclear Society, Toronto, ON (Canada); European Nuclear Society (ENS), Bern (Switzerland); Atomic Energy Society of Japan, Tokyo (Japan); Japan Society of Multiphase Flow, Kyoto (Japan). Sep 1995. (CONF-950904--Vol.2: 7. international meeting on nuclear reactor thermal hydraulics, Saratoga, NY (United States), 10-15 Sep 1995). In *Proceedings of the 7th International Meeting on Nuclear Reactor Thermal-Hydraulics NURETH-7. Volume 2, Sessions 6-11.* 795p. Source: OSTI; NTIS; INIS; GPO.

The Westinghouse Electric Corporation has designed an advanced pressurized light water reactor, AP600. This reactor is designed with a passive cooling system to remove sensible and decay heat from the containment. The heat removal path involves condensation heat transfer, aided by natural convective forces generated by buoyancy effects. A one-twelfth scale rectangular slice of the proposed reactor containment was constructed at the University of Wisconsin to simulate conditions anticipated from transients and accidents that may occur in a full scale containment vessel under a variety of conditions. Similitude of the test facility was obtained by considering the appropriate dimensionless group for the natural convective process (modified Froude number) and the aspect ratio (H/R) of the containment vessel. An experimental investigation to determine the heat transfer coefficients associated with condensation on a vertical and horizontal cooled wall (located in the scaled test section) at several different inlet steam flow rates and test section temperatures was conducted. In this series of experiments, the non-condensible mass fraction varied between (0.9-0.4) with corresponding mixture temperatures between 60-90°C. The heat transfer coefficients of the top horizontal surface varied from (82-296)W/m^{2}K and the vertical side heat transfer coefficients varied form (70-269)m^{2}K. The results were then compared to boundary layer heat and mass transfer theory by the use of the McAdams correlation for free convection.

29698 (NUREG/CP--0142-Vol.2, pp. 1535-1554) **Hydrogen behavior in ice condenser containments.** Lundstroem, P. (Power Plant Lab., Helsinki (Finland)); Hongisto, O.; Theofanous, T.G. Nuclear Regulatory Commission, Washington, DC (United States). Div. of Systems Technology; American Nuclear Society, La Grange Park, IL (United States); American Inst. of Chemical Engineers, New York, NY (United States); American Society of Mechanical Engineers, New York, NY (United States); Canadian Nuclear Society, Toronto, ON (Canada); European Nuclear Society (ENS), Bern (Switzerland); Atomic Energy Society of Japan, Tokyo (Japan); Japan Society of Multiphase Flow, Kyoto (Japan). Sep 1995. (CONF-950904--Vol.2: 7. international meeting on nuclear reactor

thermal hydraulics, Saratoga, NY (United States), 10-15 Sep 1995). In *Proceedings of the 7th International Meeting on Nuclear Reactor Thermal-Hydraulics NURETH-7. Volume 2, Sessions 6-11.* 795p. Source: OSTI; NTIS; INIS; GPO.

A new hydrogen management strategy is being developed for the Loviisa ice condenser containment. The strategy relies on containment-wide natural circulations that develop, once the ice condenser doors are forced open, to effectively produce a well-mixed behavior, and a correspondingly slow rise in hydrogen concentration. Levels can then be kept low by a distributed catalytic recombiner system, and (perhaps) an igniter system as a backup, while the associated energy releases can be effectively dissipated in the ice bed. Verification and fine-tuning of the approach is carried out experimentally in the VICTORIA facility and by associated scaling/modelling studies. VICTORIA represents an 1/15th scale model of the Loviisa containment, hydrogen is simulated by helium, and local concentration measurements are obtained by a newly developed instrument specifically for this purpose, called SPARTA. This paper is focused on experimental results from several key experiments that provide a first delineation of key behaviors.

29699 (NUREG/CP–0142-Vol.2, pp. 1555-1573) **Aerodynamics, heat and mass transfer in steam-aerosol turbulent flows in containment.** Nigmatulin, B.I. (Research & Engineering Centre of Nuclear Plants Safety, Moscow (Russian Federation)); Pershukov, V.A.; Ris, V.V. Nuclear Regulatory Commission, Washington, DC (United States). Div. of Systems Technology; American Nuclear Society, La Grange Park, IL (United States); American Inst. of Chemical Engineers, New York, NY (United States); American Society of Mechanical Engineers, New York, NY (United States); Canadian Nuclear Society, Toronto, ON (Canada); European Nuclear Society (ENS), Bern (Switzerland); Atomic Energy Society of Japan, Tokyo (Japan); Japan Society of Multiphase Flow, Kyoto (Japan). Sep 1995. (CONF-950904–Vol.2: 7. international meeting on nuclear reactor thermal hydraulics, Saratoga, NY (United States), 10-15 Sep 1995). In *Proceedings of the 7th International Meeting on Nuclear Reactor Thermal-Hydraulics NURETH-7. Volume 2, Sessions 6-11.* 795p. Source: OSTI; NTIS; INIS; GPO.

In this report an analysis of aerodynamic and heat transfer processes at the blowdown of gas-dispersed mixture into the containment volume is presented. A few models for description of the volume averaged and local characteristics are analyzed. The mathematical model for description of the local characteristics of the turbulent gas-dispersed flows was developed. The calculation of aerodynamic, heat and mass transfer characteristics was based on the Navier-Stokes, energy and gas mass fractions conservation equations. For calculation of dynamics and deposition of the aerosols the original diffusion-inertia model is developed. The pulsating characteristics of the gaseous phase were calculated on the base (k-ξ) model of turbulence with modification to account thermogravitational force action and influence of particle mass loading. The appropriate boundary conditions using the "near-wall function" approach was obtained. Testing of the mathematical models and boundary conditions has shown a good agreement between computation and data of comparison. The described mathematical models were applied to two- and three dimensional calculations of the turbulent flow in containment at the various stages of the accident.

29700 (NUREG/CP–0142-Vol.2, pp. 1574-1585) **GEYSER/TONUS: A coupled multi-D lumped parameter code for reactor thermal hydraulics analysis in case of severe accidents.** Petit, M. (Commissariat a l'Energie Atomique, Gif sur Yvette (France)); Durin, M.; Gauvain, J. Nuclear Regulatory Commission, Washington, DC (United States). Div. of Systems Technology; American Nuclear Society, La Grange Park, IL (United States); American Inst. of Chemical Engineers, New York, NY (United States); American Society of Mechanical Engineers, New York, NY (United States); Canadian Nuclear Society, Toronto, ON (Canada); European Nuclear Society (ENS), Bern (Switzerland); Atomic Energy Society of Japan, Tokyo (Japan); Japan Society of Multiphase Flow, Kyoto (Japan). Sep 1995. (CONF-950904–Vol.2: 7. international meeting on nuclear reactor thermal hydraulics, Saratoga, NY (United States), 10-15 Sep 1995). In *Proceedings of the 7th International Meeting on Nuclear Reactor Thermal-Hydraulics NURETH-7. Volume 2, Sessions 6-11.* 795p. Source: OSTI; NTIS; INIS; GPO.

In many countries, the safety requirements for future light water reactors include accounting for severe accidents in the design process. As far as the containment is concerned, the design must now include mitigation features to limit the pressure and temperature inside the building. Hydrogen concentration is also a major issue for severe accidents. In this context, new needs appear for the modeling of the thermal hydraulics inside the containment. It requires the description of complex phenomena such as condensation, stratification, transport of gases and aerosols, heat transfers. Moreover, the effect of mitigation systems will increase the heterogeneities in the building, and most of those phenomena can be coupled, as for example hydrogen stratification and condensation. To model such a complex situation, the use of multi-dimensional computer codes seems to be necessary in case of large volumes. The aim of the GEYSER/TONUS computer code is to fulfill this need. This code is currently under development at CEA in Saclay. It will allow the coupling of parts of the containment described in a lumped parameter manner, together with meshed parts. Emphasis is put on the numerical methods used to solve the transient problem, as the objective is to be able to treat complete scenarios. Physical models of classical lumped parameters codes will adapted for the spatially described zones. The code is developed in the environment of the CASTEM 2000/TRIO EF system which allows, thanks to its modular conception, to construct sophisticated applications based upon it.

29701 (NUREG/CP–0142-Vol.3, pp. 1586-1606) **On the constitutive description of the microinteractions concept in steam explosions.** Chen, X. (Univ. of California, Santa Barbara, CA (United States)); Yuen, W.W.; Theofanous, T.G. Nuclear Regulatory Commission, Washington, DC (United States). Div. of Systems Technology; American Nuclear Society, La Grange Park, IL (United States); American Inst. of Chemical Engineers, New York, NY (United States); American Society of Mechanical Engineers, New York, NY (United States); Canadian Nuclear Society, Toronto, ON (Canada); European Nuclear Society (ENS), Bern (Switzerland); Atomic Energy Society of Japan, Tokyo (Japan); Japan Society of Multiphase Flow, Kyoto (Japan). Sep 1995. (CONF-950904–Vol.3: 7. international meeting on nuclear reactor thermal hydraulics, Saratoga, NY (United States), 10-15 Sep 1995). In *Proceedings of the 7th International Meeting on Nuclear Reactor Thermal-Hydraulics NURETH-7, Volume 3, Sessions 12-16.* 1001p. Source: OSTI; NTIS; INIS; GPO.

This paper elaborates on the constitutive description of the "microinteraction" model used by the computer code ESPROSE.m to simulate the propagation phase of steam explosions. The approach is based on a series of experiments, in the SIGMA-2000 facility, involving molten drops of tin made to explode under sustained pressure fields; an environment similar to that of a fully-developed large-scale detonation. The experimental ranges cover shock pressures of up to 204 bar, melt temperatures of up to 1800°C, and series of isothermal runs, using gallium drops, are also included. The results indicate that, to a first approximation, the basic form of the constitutive laws hypothesized in the original formulation of ESPROSE.m is appropriate. Moreover, through detailed comparison of data with numerical experiments, certain parameters appearing in these laws could be identified quantitatively.

29702 (NUREG/CP–0142-Vol.3, pp. 1607-1633) **Correlations between the disintegration of melt and the measured impulses in steam explosions.** Froehlich, G. (Univ. of Stuttgart (Germany)); Linca, A.; Schindler, M. Nuclear Regulatory Commission, Washington, DC (United States). Div. of Systems Technology; American Nuclear Society, La Grange Park, IL (United States); American Inst. of Chemical Engineers, New York, NY (United States); American Society of Mechanical Engineers, New York, NY (United States); Canadian Nuclear Society, Toronto, ON (Canada); European Nuclear Society (ENS), Bern (Switzerland); Atomic Energy Society of Japan, Tokyo (Japan); Japan Society of Multiphase Flow, Kyoto (Japan). Sep 1995. (CONF-950904–Vol.3: 7. international meeting on nuclear reactor thermal hydraulics, Saratoga, NY (United States), 10-15 Sep 1995). In *Proceedings of the 7th International Meeting on Nuclear Reactor Thermal-Hydraulics NURETH-7, Volume 3, Sessions 12-16.* 1001p. Source: OSTI; NTIS; INIS; GPO.

To find our correlations in steam explosions (melt water interactions) between the measured impulses and the disintegration of the

melt, experiments were performed in three configurations i.e. stratified, entrapment and jet experiments. Linear correlations were detected between the impulse and the total surface of the fragments. Theoretical considerations point out that a linear correlation assumes superheating of a water layer around the fragments of a constant thickness during the fragmentation process to a constant temperature (here the homogeneous nucleation temperature of water was assumed) and a constant expansion velocity of the steam in the main expansion time. The correlation constant does not depend on melt temperature and trigger pressure, but it depends on the configuration of the experiment or of a scenario of an accident. Further research is required concerning the correlation constant. For analysing steam explosion accidents the explosivity is introduced. The explosivity is a mass specific impulse. The explosivity is linear correlated with the degree of fragmentation. Knowing the degree of fragmentation with proper correlation constant the explosivity can be calculated and from the explosivity combined with the total mass of fragments the impulse is obtained which can be used to an estimation of the maximum force.

29703 (NUREG/CP–0142-Vol.3, pp. 1634-1652) **Analysis of supercritical vapor explosions using thermal detonation wave theory.** Shamoun, B.I. (Univ. of Wisconsin, Madison, WI (United States)); Corradini, M.L. Nuclear Regulatory Commission, Washington, DC (United States). Div. of Systems Technology; American Nuclear Society, La Grange Park, IL (United States); American Inst. of Chemical Engineers, New York, NY (United States); American Society of Mechanical Engineers, New York, NY (United States); Canadian Nuclear Society, Toronto, ON (Canada); European Nuclear Society (ENS), Bern (Switzerland); Atomic Energy Society of Japan, Tokyo (Japan); Japan Society of Multiphase Flow, Kyoto (Japan). Sep 1995. (CONF-950904–Vol.3: 7. international meeting on nuclear reactor thermal hydraulics, Saratoga, NY (United States), 10-15 Sep 1995). In *Proceedings of the 7th International Meeting on Nuclear Reactor Thermal-Hydraulics NURETH-7, Volume 3, Sessions 12-16.* 1001p. Source: OSTI; NTIS; INIS; GPO.

The interaction of certain materials such as Al_2O_3 with water results in vapor explosions with very high (supercritical) pressures and propagation velocities. A quasi-steady state analysis of supercritical detonation in one-dimensional multiphase flow was applied to analyze experimental data of the KROTOS (26-30) set of experiments conducted at the Joint Research Center at Ispra, Italy. In this work we have applied a new method of solution which allows for partial fragmentation of the fuel in the shock adiabatic thermodynamic model. This method uses known experiment values of the shock pressure and propagation velocity to estimate the initial mixing conditions of the experiment. The fuel and coolant were both considered compressible in this analysis. In KROTOS 26, 28, 29, and 30 the measured values of the shock pressure by the experiment were found to be higher than 25, 50, 100, and 100 Mpa respectively. Using the above data for the wave velocity and our best estimate for the values of the pressure, the predicted minimum values of the fragmented mass of the fuel were found to be 0.026. 0.04, 0.057, and 0.068 kg respectively. The predicted values of the work output corresponding to the above fragmented masses of the fuel were found to be 40, 84, 126, and 150 kJ respectively, with predicted initial void fractions of 112%, 12.5%, 8%, and 6% respectively.

29704 (NUREG/CP–0142-Vol.3, pp. 1653-1662) **The numerical methods for the development of the mixture region in the vapor explosion simulations.** Yang, Y. (Univ. of Tokyo (Japan)); Ohashi, H.; Akiyama, M. Nuclear Regulatory Commission, Washington, DC (United States). Div. of Systems Technology; American Nuclear Society, La Grange Park, IL (United States); American Inst. of Chemical Engineers, New York, NY (United States); American Society of Mechanical Engineers, New York, NY (United States); Canadian Nuclear Society, Toronto, ON (Canada); European Nuclear Society (ENS), Bern (Switzerland); Atomic Energy Society of Japan, Tokyo (Japan); Japan Society of Multiphase Flow, Kyoto (Japan). Sep 1995. (CONF-950904–Vol.3: 7. international meeting on nuclear reactor thermal hydraulics, Saratoga, NY (United States), 10-15 Sep 1995). In *Proceedings of the 7th International Meeting on Nuclear Reactor Thermal-Hydraulics NURETH-7, Volume 3, Sessions 12-16.* 1001p. Source: OSTI; NTIS; INIS; GPO.

An attempt to numerically simulate the process of the vapor explosion with a general multi-component and multi-dimension code is being challenged. Because of the rapid change of the flow field and extremely nonuniform distribution of the components in the system of the vapor explosion, the numerical divergence and diffusion are subject to occur easily. A dispersed component model and a multiregion scheme, by which these difficulties can be effectively overcome, were proposed. The simulations have been performed for the processes of the premixing and the fragmentation propagation in the vapor explosion.

29705 (NUREG/CP–0142-Vol.3, pp. 1663-1676) **Thermal-hydraulic behaviors of vapor-liquid interface due to arrival of a pressure wave.** Inoue, Akira (Tokyo Institute of Technology (Japan)); Fujii, Yoshifumi; Matsuzaki, Mitsuo. Nuclear Regulatory Commission, Washington, DC (United States). Div. of Systems Technology; American Nuclear Society, La Grange Park, IL (United States); American Inst. of Chemical Engineers, New York, NY (United States); American Society of Mechanical Engineers, New York, NY (United States); Canadian Nuclear Society, Toronto, ON (Canada); European Nuclear Society (ENS), Bern (Switzerland); Atomic Energy Society of Japan, Tokyo (Japan); Japan Society of Multiphase Flow, Kyoto (Japan). Sep 1995. (CONF-950904–Vol.3: 7. international meeting on nuclear reactor thermal hydraulics, Saratoga, NY (United States), 10-15 Sep 1995). In *Proceedings of the 7th International Meeting on Nuclear Reactor Thermal-Hydraulics NURETH-7, Volume 3, Sessions 12-16.* 1001p. Source: OSTI; NTIS; INIS; GPO.

In the vapor explosion, a pressure wave (shock wave) plays a fundamental role for triggering, propagation and enhancement of the explosion. Energy of the explosion is related to the magnitude of heat transfer rate from hot liquid to cold volatile one. This is related to an increasing rate of interface area and to an amount of transient heat flux between the liquids. In this study, the characteristics of transient heat transfer and behaviors of vapor film both on the platinum tube and on the hot melt tin drop, under same boundary conditions have been investigated. It is considered that there exists a fundamental mechanism of the explosion in the initial expansion process of the hot liquid drop immediately after arrival of pressure wave. The growth rate of the vapor film is much faster on the hot liquid than that on the solid surface. Two kinds of roughness were observed, one due to the Taylor instability, by rapid growth of the explosion bubble, and another, nucleation sites were observed at the vapor-liquid interface. Based on detailed observation of early stage interface behaviors after arrival of a pressure wave, the thermal fragmentation mechanism is proposed.

29706 (NUREG/CP–0142-Vol.3, pp. 1677-1687) **Boiling characteristics of dilute polymer solutions and implications for the suppression of vapor explosions.** Bang, K.H. (Univ. of Science and Technology, Pohang (Korea, Republic of)); Kim, M.H. Nuclear Regulatory Commission, Washington, DC (United States). Div. of Systems Technology; American Nuclear Society, La Grange Park, IL (United States); American Inst. of Chemical Engineers, New York, NY (United States); American Society of Mechanical Engineers, New York, NY (United States); Canadian Nuclear Society, Toronto, ON (Canada); European Nuclear Society (ENS), Bern (Switzerland); Atomic Energy Society of Japan, Tokyo (Japan); Japan Society of Multiphase Flow, Kyoto (Japan). Sep 1995. (CONF-950904–Vol.3: 7. international meeting on nuclear reactor thermal hydraulics, Saratoga, NY (United States), 10-15 Sep 1995). In *Proceedings of the 7th International Meeting on Nuclear Reactor Thermal-Hydraulics NURETH-7, Volume 3, Sessions 12-16.* 1001p. Source: OSTI; NTIS; INIS; GPO.

Quenching experiments of hot solid spheres in dilute aqueous solutions of polyethylene oxide polymer have been conducted for the purpose of investigating the physical mechanisms of the suppression of vapor explosions in this polymer solutions. Two spheres of 22.2mm and 9.5mm-diameter were tested in the polymer solutions of various concentrations at 30°C. Minimum film boiling temperature (ΔT_{MFB}) in this highly-subcooled liquid rapidly decreased from over 700°c for pure water to about 150°C as the polymer concentration was increased up to 300ppm for 22.2mm sphere, and it decreased to 350°C for 9.5mm sphere. This rapid reduction of minimum film boiling temperature in the PEO aqueous

solutions can explain its ability of the suppression of spontaneous vapor explosions. The ability of suppression of vapor explosions by dilute polyethylene oxide solutions against an external trigger pressure was tested by dropping molten tin into the polymer solutions at 25°C. It was observed that in 50ppm solutions more mass fragmented than in pure water, but produced weaker explosion pressures. The explosion was completely suppressed in 300ppm solutions with the external trigger. The debris size distributions of fine fragments smaller than 0.7mm were shown almost identical regardless of the polymer concentrations.

29707 (NUREG/CP–0142-Vol.3, pp. 1688-1711) **Experimental investigation of 150-KG-scale corium melt jet quenching in water.** Magallon, D.; Hohmann, H. Nuclear Regulatory Commission, Washington, DC (United States). Div. of Systems Technology; American Nuclear Society, La Grange Park, IL (United States); American Inst. of Chemical Engineers, New York, NY (United States); American Society of Mechanical Engineers, New York, NY (United States); Canadian Nuclear Society, Toronto, ON (Canada); European Nuclear Society (ENS), Bern (Switzerland); Atomic Energy Society of Japan, Tokyo (Japan); Japan Society of Multiphase Flow, Kyoto (Japan). Sep 1995. (CONF-950904–Vol.3: 7. international meeting on nuclear reactor thermal hydraulics, Saratoga, NY (United States), 10-15 Sep 1995). In *Proceedings of the 7th International Meeting on Nuclear Reactor Thermal-Hydraulics NURETH-7, Volume 3, Sessions 12-16.* 1001p. Source: OSTI; NTIS; INIS; GPO.

This paper compares and discusses the results of two large scale FARO quenching tests known as L-11 and L-14, which involved, respectively, 151 kg of W% 76.7 UO_2 + 19.2 ZrO_2 + 4.1 Zr and 125 kg of W% 80 UO_2 + 20 ZrO_2 melts poured into 600-kg, 2-m-depth water at saturation at 5.0 MPa. The results are further compared with those of two previous tests performed using a pure oxidic melt, respectively 18 and 44 kg of W% 80 UO_2 + 20 ZrO_2 melt quenched in 1-m-depth water at saturation at 5.0 MPa. In all the tests, significant breakup and quenching took place during the melt fall through the water. No steam explosion occurred. In the tests performed with a pure oxide UO_2-ZrO_2 melt, part of the corium (from 1/6 to 1/3) did not breakup and reached the bottom plate still molten whatever the water depth was. Test L-11 data suggest that full oxidation and complete breakup of the melt occurred during the melt fall through the water. A proportion of 64% of the total energy content of the melt was released to the water during this phase (~1.5 s), against 44% for L-14. The maximum temperature increase of the bottom plate was 330 K (L-14). The mean particle size of the debris ranged between 2.5 and 4.8mm.

29708 (NUREG/CP–0142-Vol.3, pp. 1712-1727) **FCI experiments in the corium/water system.** Huhtiniemi, I.; Hohmann, H.; Magallon, D. Nuclear Regulatory Commission, Washington, DC (United States). Div. of Systems Technology; American Nuclear Society, La Grange Park, IL (United States); American Inst. of Chemical Engineers, New York, NY (United States); American Society of Mechanical Engineers, New York, NY (United States); Canadian Nuclear Society, Toronto, ON (Canada); European Nuclear Society (ENS), Bern (Switzerland); Atomic Energy Society of Japan, Tokyo (Japan); Japan Society of Multiphase Flow, Kyoto (Japan). Sep 1995. (CONF-950904–Vol.3: 7. international meeting on nuclear reactor thermal hydraulics, Saratoga, NY (United States), 10-15 Sep 1995). In *Proceedings of the 7th International Meeting on Nuclear Reactor Thermal-Hydraulics NURETH-7, Volume 3, Sessions 12-16.* 1001p. Source: OSTI; NTIS; INIS; GPO.

The KROTOS fuel coolant interaction (FCI) tests aim at providing benchmark data to examine the effect of fuel/coolant initial conditions and mixing on explosion energetics. Experiments, fundamental in nature, are performed in well-controlled geometries and are complementary to the FARO large scale tests. Recently, a new test series was started using 3 kg of prototypical core material (80 w/o UO_2, 20 w/o ZrO_2) which was poured into a water column of $\leq$ 1.25 m in height (95 mm and 200 mm in diameter) under 0.1 MPa ambient pressure. Four tests have been performed in the test section of 95 mm in diameter (ID) with different subcooling levels (10-80K) and with and without an external trigger. Additionally, one test has been performed with a test section of 200 mm in diameter (ID) and with an external trigger. No spontaneous or triggered energetic FCIs (steam explosions) have been observed in these corium tests. This is in sharp contrast with the steam explosions observed in the previously reported Al_2O_3 test series which had the same initial conditions of ambient pressure and subcooling. The post-test analysis of the corium experiments indicated that strong vaporisation at the melt/water contact led to a partial expulsion of the melt from the test section into the pressure vessel. In order to avoid this and to obtain a good penetration and premixing os the corium melt, an additional test has been performed with a larger diameter test section. In all the UO_2-ZrO_2 tests an efficient quenching process (0.7-1.2 MW/kg-melt) with total fuel fragmentation (mass mean diameter 1.4-2.5 mm) was observed. Results from Al_2O_3 tests under the same initial conditions are also presented for further confirmation of the observed differences in behaviour between Al_2O_3 and UO_2-ZrO_2 melts.

29709 (NUREG/CP–0142-Vol.3, pp. 1728-1742) **Experimental studies of thermal and chemical interactions between oxide and silicide nuclear fuels with water.** farahani, A.A. (Univ. of Wisconsi, Madison, WI (United States)); Corradini, M.L. Nuclear Regulatory Commission, Washington, DC (United States). Div. of Systems Technology; American Nuclear Society, La Grange Park, IL (United States); American Inst. of Chemical Engineers, New York, NY (United States); American Society of Mechanical Engineers, New York, NY (United States); Canadian Nuclear Society, Toronto, ON (Canada); European Nuclear Society (ENS), Bern (Switzerland); Atomic Energy Society of Japan, Tokyo (Japan); Japan Society of Multiphase Flow, Kyoto (Japan). Sep 1995. (CONF-950904–Vol.3: 7. international meeting on nuclear reactor thermal hydraulics, Saratoga, NY (United States), 10-15 Sep 1995). In *Proceedings of the 7th International Meeting on Nuclear Reactor Thermal-Hydraulics NURETH-7, Volume 3, Sessions 12-16.* 1001p. Source: OSTI; NTIS; INIS; GPO.

Given some transient power/cooling mismatch is a nuclear reactor and its inability to establish the necessary core cooling, energetic fuel-coolant interactions (FCI's commonly called 'vapor explosions') could occur as a result of the core melting and coolant contact. Although a large number of studies have been done on energetic FCI's, very few experiments have been performed with the actual fuel materials postulated to be produced in severe accidents. Because of the scarcity of well-characterized FCI data for uranium allows in noncommercial reactors (cermet and silicide fuels), we have conducted a series of experiments to provide a data base for the foregoing materials. An existing 1-D shock-tube facility was modified to handle depleted radioactive materials (U_3O_8-Al, and U_3Si_2-Al). Our objectives have been to determine the effects of the initial fuel composition and temperature and the driving pressure (triggering) on the explosion work output, dynamic pressures, transient temperatures, and the hydrogen production. Experimental results indicate limited energetics, mainly thermal interactions, for these fuel materials as compared to aluminum where more chemical reactions occur between the molten aluminum and water.

29710 (NUREG/CP–0142-Vol.3, pp. 1743-1753) **The effect of constraint on fuel-coolant interactions in a confined geometry.** Park, H. (Univ. of Wisconsin, Madison, WI (United States)); Corradini, M.L. Nuclear Regulatory Commission, Washington, DC (United States). Div. of Systems Technology; American Nuclear Society, La Grange Park, IL (United States); American Inst. of Chemical Engineers, New York, NY (United States); American Society of Mechanical Engineers, New York, NY (United States); Canadian Nuclear Society, Toronto, ON (Canada); European Nuclear Society (ENS), Bern (Switzerland); Atomic Energy Society of Japan, Tokyo (Japan); Japan Society of Multiphase Flow, Kyoto (Japan). Sep 1995. (CONF-950904–Vol.3: 7. international meeting on nuclear reactor thermal hydraulics, Saratoga, NY (United States), 10-15 Sep 1995). In *Proceedings of the 7th International Meeting on Nuclear Reactor Thermal-Hydraulics NURETH-7, Volume 3, Sessions 12-16.* 1001p. Source: OSTI; NTIS; INIS; GPO.

A Fuel-Coolant Interaction (FCI or vapor explosion) is the phenomena in which a hot liquid rapidly transfers its internal energy into a surrounding colder and more volatile liquid. The energetics of such a complex multi-phase and multi-component phenomenon is partially determined by the surrounding boundary conditions. As

one of the boundary conditions, we studied the effect of constraint on FCIs. The WFCI-D series of experiments were performed specifically to observe this effect. The results from these and our previous WFCI tests as well as those of other investigators are compared.

29711 (NUREG/CP–0142-Vol.3, pp. 1754-1778) **The mixing of particle clouds plunging into water.** Angelini, S. (Univ. of California, Santa Barbara, CA (United States)); Theofanous, T.G.; Yuen, W.W. Nuclear Regulatory Commission, Washington, DC (United States). Div. of Systems Technology; American Nuclear Society, La Grange Park, IL (United States); American Inst. of Chemical Engineers, New York, NY (United States); American Society of Mechanical Engineers, New York, NY (United States); Canadian Nuclear Society, Toronto, ON (Canada); European Nuclear Society (ENS), Bern (Switzerland); Atomic Energy Society of Japan, Tokyo (Japan); Japan Society of Multiphase Flow, Kyoto (Japan). Sep 1995. (CONF-950904–Vol.3: 7. international meeting on nuclear reactor thermal hydraulics, Saratoga, NY (United States), 10-15 Sep 1995). In *Proceedings of the 7th International Meeting on Nuclear Reactor Thermal-Hydraulics NURETH-7, Volume 3, Sessions 12-16.* 1001p. Source: OSTI; NTIS; INIS; GPO.

This work addresses certain fundamental aspects of the premixing phase of steam explosions, At issue are the multifield interaction aspects under highly transient, multidimensional conditions, and in presence of strong phase changes. They are addressed in an experiment (the MAGICO-2000) involving well-characterized particle clouds mixing with water, and detailed measurements on both external and internal characteristics of the mixing zone. Both cold and hot (up to 1500°C) particle clouds are considered in conjunction with saturated and subcooled water pools. The PMALPHA code is used as an aid in interpreting the experimental results, and the exercise reveals good predictive capabilities for it.

29712 (NUREG/CP–0142-Vol.3, pp. 1779-1796) **Experimental studies of thermal and chemical interactions between molten aluminum and water.** Farahani, A.A. (Univ. of Wisconsin, Madison, WI (United States)); Corradini, M.L. Nuclear Regulatory Commission, Washington, DC (United States). Div. of Systems Technology; American Nuclear Society, La Grange Park, IL (United States); American Inst. of Chemical Engineers, New York, NY (United States); American Society of Mechanical Engineers, New York, NY (United States); Canadian Nuclear Society, Toronto, ON (Canada); European Nuclear Society (ENS), Bern (Switzerland); Atomic Energy Society of Japan, Tokyo (Japan); Japan Society of Multiphase Flow, Kyoto (Japan). Sep 1995. (CONF-950904–Vol.3: 7. international meeting on nuclear reactor thermal hydraulics, Saratoga, NY (United States), 10-15 Sep 1995). In *Proceedings of the 7th International Meeting on Nuclear Reactor Thermal-Hydraulics NURETH-7, Volume 3, Sessions 12-16.* 1001p. Source: OSTI; NTIS; INIS; GPO.

The possibility of rapid physical and chemical aluminum/water interactions during a core melt accident in a noncommercial reactor (e.g., HFIR, ATR) has resulted in extensive research to determine the mechanism by which these interactions occur and propagate on an explosive time scale. These events have been reported in nuclear testing facilities, i.e., during SPERT 1D experiment, and also in aluminum casting industries. Although rapid chemical reactions between molten aluminum and water have been subject of many studies, very few reliable measurements of the extent of the chemical reactions have thus far been made. We have modified an existing 1-D shock tube facility to perform experiments in order to determine the extent of the explosive thermal/chemical interactions between molton aluminum and water by measuring important physical quantities such as the maximum dynamic pressure and the amount of the generated hydrogen. Experimental results show that transient pressures greater than 69 MPa with a rise time of less than 125 μsec can occur as the result of the chemical reaction of 4.2 grams of molton aluminum (approximately 15% of the total mass of the fuel of 28 grams) at 980 C with room temperature water.

29713 (NUREG/CP–0142-Vol.3, pp. 1797-1808) **Interaction between the radiative flux emitted by a corium melt and aerosols from corium/concrete interaction.** Zabiego, M. (CEA-DRN/DER/SERA - CE Cadarache, Saint-Paul-Lez-Durance (France)); Cognet, G.; Henderson, D. Nuclear Regulatory Commission, Washington, DC (United States). Div. of Systems Technology; American Nuclear Society, La Grange Park, IL (United States); American Inst. of Chemical Engineers, New York, NY (United States); American Society of Mechanical Engineers, New York, NY (United States); Canadian Nuclear Society, Toronto, ON (Canada); European Nuclear Society (ENS), Bern (Switzerland); Atomic Energy Society of Japan, Tokyo (Japan); Japan Society of Multiphase Flow, Kyoto (Japan). Sep 1995. (CONF-950904–Vol.3: 7. international meeting on nuclear reactor thermal hydraulics, Saratoga, NY (United States), 10-15 Sep 1995). In *Proceedings of the 7th International Meeting on Nuclear Reactor Thermal-Hydraulics NURETH-7, Volume 3, Sessions 12-16.* 1001p. Source: OSTI; NTIS; INIS; GPO.

In this paper we present a one-dimensional numerical model that deals with radiative transfer in a medium where aerosols are present. This model is written with the aim of performing radiative transfer calculations in the framework of severe Pressurized Water Reactor accidents, especially during the last stage of such an accident Molten Core Concrete Interaction (MCCI) when aerosols are very numerous. We explain the theoretical basis of our model, writing the general radiative transfer equation, knowing that aerosol droplets participate in radiation transport. We then simplify this equation for a one-dimensional medium and we propose to solve it using the spherical harmonics approximation. This gives us the radiative intensity and we can then deduce the radiative flux. Aerosol optical properties (extinction and scattering coefficients) are also required in such a calculation. They are determined using Rayleigh or Mie theory, depending, depending on the aerosol size. In order to provide an example of results one can expect from such a calculation, we applied our model to a test problem with given aerosol size and concentration distributions. Our example does not model any experiment explicitly but the physical conditions used are very close to the L4 test from the Advanced Containment Experiment (ACE) program.

29714 (NUREG/CP–0142-Vol.3, pp. 1809-1829) **Modeling of heat and mass transfer processes during core melt discharge from a reactor pressure vessel.** Dinh, T.N. (Royal Institute of Technology, Stockholm (Sweden)); Bui, V.A.; Nourgaliev, R.R. Nuclear Regulatory Commission, Washington, DC (United States). Div. of Systems Technology; American Nuclear Society, La Grange Park, IL (United States); American Inst. of Chemical Engineers, New York, NY (United States); American Society of Mechanical Engineers, New York, NY (United States); Canadian Nuclear Society, Toronto, ON (Canada); European Nuclear Society (ENS), Bern (Switzerland); Atomic Energy Society of Japan, Tokyo (Japan); Japan Society of Multiphase Flow, Kyoto (Japan). Sep 1995. (CONF-950904–Vol.3: 7. international meeting on nuclear reactor thermal hydraulics, Saratoga, NY (United States), 10-15 Sep 1995). In *Proceedings of the 7th International Meeting on Nuclear Reactor Thermal-Hydraulics NURETH-7, Volume 3, Sessions 12-16.* 1001p. Source: OSTI; NTIS; INIS; GPO.

The objective of the paper is to study heat and mass transfer processes related to core melt discharge from a reactor vessel is a severe light water reactor accident. The phenomenology of the issue includes (1) melt convection in and heat transfer from the melt pool in contact with the vessel lower head wall; (2) fluid dynamics and heat transfer of the melt flow in the growing discharge hole; and (3) multi-dimensional heat conduction in the ablating lower head wall. A program of model development, validation and application is underway (i) to analyse the dominant physical mechanisms determining characteristics of the lower head ablation process; (ii) to develop and validate efficient analytic/computational methods for estimating heat and mass transfer under phase-change conditions in irregular moving-boundary domains; and (iii) to investigate numerically the melt discharge phenomena in a reactor-scale situation, and, in particular, the sensitivity of the melt discharge transient to structural differences and various in-vessel melt progression scenarios. The paper presents recent results of the analysis and model development work supporting the simulant melt-structure interaction experiments.

29715 (NUREG/CP–0142-Vol.3, pp. 1830-1850) **Results of international standard problem No. 36 severe fuel damage experiment of a VVER fuel bundle.** Firnhaber, M. (Gesellschaft fuer Anlagen-und Reaktorsicherheit, Koeln (Germany)); Yegorova, L.; Brockmeier, U. Nuclear Regulatory Commission, Washington, DC (United States). Div. of Systems Technology; American Nuclear Society, La Grange Park, IL (United States); American Inst. of Chemical Engineers, New York, NY (United States); American Society of Mechanical Engineers, New York, NY (United States); Canadian Nuclear Society, Toronto, ON (Canada); European Nuclear Society (ENS), Bern (Switzerland); Atomic Energy Society of Japan, Tokyo (Japan); Japan Society of Multiphase Flow, Kyoto (Japan). Sep 1995. Contract RS 871 A. (CONF-950904–Vol.3: 7. international meeting on nuclear reactor thermal hydraulics, Saratoga, NY (United States), 10-15 Sep 1995). In *Proceedings of the 7th International Meeting on Nuclear Reactor Thermal-Hydraulics NURETH-7, Volume 3, Sessions 12-16.* 1001p. Source: OSTI; NTIS; INIS; GPO.

International Standard Problems (ISP) organized by the OECD are defined as comparative exercises in which predictions with different computer codes for a given physical problem are compared with each other and with a carefully controlled experimental study. The main goal of ISP is to increase confidence in the validity and accuracy of analytical tools used in assessing the safety of nuclear installations. In addition, it enables the code user to gain experience and to improve his competence. This paper presents the results and assessment of ISP No. 36, which deals with the early core degradation phase during an unmitigated severe LWR accident in a Russian type VVER. Representatives of 17 organizations participated in the ISP using the codes ATHLET-CD, ICARE2, KESS-III, MELCOR, SCDAP/RELAP5 and RAPTA. Some participants performed several calculations with different codes. As experimental basis the severe fuel damage experiment CORA-W2 was selected. The main phenomena investigated are thermal behavior of fuel rods, onset of temperature escalation, material behavior and hydrogen generation. In general, the calculations give the right tendency of the experimental results for the thermal behavior, the hydrogen generation and, partly, for the material behavior. However, some calculations deviate in important quantities - e.g. some material behavior data - showing remarkable discrepancies between each other and from the experiments. The temperature history of the bundle up to the beginning of significant oxidation was calculated quite well. Deviations seem to be related to the overall heat balance. Since the material behavior of the bundle is to a great extent influenced by the cladding failure criteria a more realistic cladding failure model should be developed at least for the detailed, mechanistic codes. Regarding the material behavior and flow blockage some models for the material interaction as well as for relocation and refreezing requires further improvement.

29716 (NUREG/CP–0142-Vol.3, pp. 1851-1862) **Oxidation during reflood of reactor core with melting cladding.** Siefken, L.J. (and others); Allison, C.M.; Davis, K.L. Nuclear Regulatory Commission, Washington, DC (United States). Div. of Systems Technology; American Nuclear Society, La Grange Park, IL (United States); American Inst. of Chemical Engineers, New York, NY (United States); American Society of Mechanical Engineers, New York, NY (United States); Canadian Nuclear Society, Toronto, ON (Canada); European Nuclear Society (ENS), Bern (Switzerland); Atomic Energy Society of Japan, Tokyo (Japan); Japan Society of Multiphase Flow, Kyoto (Japan). Sep 1995. (CONF-950904–Vol.3: 7. international meeting on nuclear reactor thermal hydraulics, Saratoga, NY (United States), 10-15 Sep 1995). In *Proceedings of the 7th International Meeting on Nuclear Reactor Thermal-Hydraulics NURETH-7, Volume 3, Sessions 12-16.* 1001p. Source: OSTI; NTIS; INIS; GPO.

Models were recently developed and incorporated into the SCDAP/RELAP5 code for calculating the oxidation of fuel rods during cladding meltdown and reflood. Experiments have shown that a period of intense oxidation may occur when a hot partially oxidized reactor core is reflooded. This paper offers an explanation of the cladding meltdown and oxidation processes that cause this intense period of oxidation. Models for the cladding meltdown and oxidation processes are developed. The models are assessed by simulating a severe fuel damage experiment that involved reflood. The models for cladding meltdown and oxidation were found to improve calculation of the temperature and oxidation of fuel rods during the period in which hot fuel rods are reflooded.

29717 (NUREG/CP–0142-Vol.3, pp. 1863-1880) **Crust formation and its effect on the molten pool coolability.** Park, R.J. (Korea Atomic Energy Research Institute, Taejon (Korea, Republic of)); Lee, S.J.; Sim, S.K. Nuclear Regulatory Commission, Washington, DC (United States). Div. of Systems Technology; American Nuclear Society, La Grange Park, IL (United States); American Inst. of Chemical Engineers, New York, NY (United States); American Society of Mechanical Engineers, New York, NY (United States); Canadian Nuclear Society, Toronto, ON (Canada); European Nuclear Society (ENS), Bern (Switzerland); Atomic Energy Society of Japan, Tokyo (Japan); Japan Society of Multiphase Flow, Kyoto (Japan). Sep 1995. (CONF-950904–Vol.3: 7. international meeting on nuclear reactor thermal hydraulics, Saratoga, NY (United States), 10-15 Sep 1995). In *Proceedings of the 7th International Meeting on Nuclear Reactor Thermal-Hydraulics NURETH-7, Volume 3, Sessions 12-16.* 1001p. Source: OSTI; NTIS; INIS; GPO.

Experimental and analytical studies of the crust formation and its effect on the molten pool coolability have been performed to examine the crust formation process as a function of boundary temperatures as well as to investigate heat transfer characteristics between molten pool and overlying water in order to evaluate coolability of the molten pool. The experimental test results have shown that the surface temperature of the bottom plate is a dominant parameter in the crust formation process of the molten pool. It is also found that the crust thickness of the case with direct coolant injection into the molten pool is greater than that of the case with a heat exchanger. Increasing mass flow rate of direct coolant injection to the molten pool does not affect the temperature of molten pool after the crust has been formed in the molten pool because the crust behaves as a thermal barrier. The Nusselt number between the molten pool and the coolant of the case with no crust formation is greater than that of the case with crust formation. The results of FLOW-3D analyses have shown that the temperature distribution contributes to the crust formation process due to Rayleigh-Benard natural convection flow.

29718 (NUREG/CP–0142-Vol.3, pp. 1881-1888) **Simulation of the thermalhydraulic behavior of a molten core within a structure, with the three dimensions three components TOLBIAC code.** Spindler, B. (Centre d'Etudes Nucleaires de Grenoble (France)); Moreau, G.M.; Pigny S. Nuclear Regulatory Commission, Washington, DC (United States). Div. of Systems Technology; American Nuclear Society, La Grange Park, IL (United States); American Inst. of Chemical Engineers, New York, NY (United States); American Society of Mechanical Engineers, New York, NY (United States); Canadian Nuclear Society, Toronto, ON (Canada); European Nuclear Society (ENS), Bern (Switzerland); Atomic Energy Society of Japan, Tokyo (Japan); Japan Society of Multiphase Flow, Kyoto (Japan). Sep 1995. (CONF-950904–Vol.3: 7. international meeting on nuclear reactor thermal hydraulics, Saratoga, NY (United States), 10-15 Sep 1995). In *Proceedings of the 7th International Meeting on Nuclear Reactor Thermal-Hydraulics NURETH-7, Volume 3, Sessions 12-16.* 1001p. Source: OSTI; NTIS; INIS; GPO.

The TOLBIAC code is devoted to the simulation of the behavior of a molten core within a structure (pressure vessel of core catcher), taking into account the relative position of the core components, the wall ablation and the crust formation. The code is briefly described: 3D model, physical properties and constitutive laws. wall ablation and crust model. Two results are presented: the simulation of the COPO experiment (natural convection with water in a 1/2 scale elliptic pressure vessel), and the simulation of the behavior of a corium in a PWR pressure vessel, with ablation and crust formation.

29719 (NUREG/CP–0142-Vol.3, pp. 1889-1913) **The modeling of core melting and in-vessel corium relocation in the APRIL code.** Kim. S.W. (Rensselaer Polytechnic Institute, Troy, NY (United States)); Podowski, M.Z.; Lahey, R.T. Nuclear Regulatory Commission, Washington, DC (United States). Div. of Systems Technology; American Nuclear Society, La Grange Park, IL (United States); American Inst. of Chemical Engineers, New York, NY

(United States); American Society of Mechanical Engineers, New York, NY (United States); Canadian Nuclear Society, Toronto, ON (Canada); European Nuclear Society (ENS), Bern (Switzerland); Atomic Energy Society of Japan, Tokyo (Japan); Japan Society of Multiphase Flow, Kyoto (Japan). Sep 1995. (CONF-950904–Vol.3: 7. international meeting on nuclear reactor thermal hydraulics, Saratoga, NY (United States), 10-15 Sep 1995). In *Proceedings of the 7th International Meeting on Nuclear Reactor Thermal-Hydraulics NURETH-7, Volume 3, Sessions 12-16.* 1001p. Source: OSTI; NTIS; INIS; GPO.

This paper is concerned with the modeling of severe accident phenomena in boiling water reactors (BWR). New models of core melting and in-vessel corium debris relocation are presented, developed for implementation in the APRIL computer code. The results of model testing and validations are given, including comparisons against available experimental data and parametric/sensitivity studies. Also, the application of these models, as parts of the APRIL code, is presented to simulate accident progression in a typical BWR reactor.

29720 (NUREG/CP–0142-Vol.3, pp. 1914-1929) **Code package "SVECHA": Modeling of core degradation phenomena at severe accidents.** Veshchunov, M.S. (Nuclear Safety Institute, Moscow (Russian Federation)); Kisselev, A.E.; Palagin, A.V. Nuclear Regulatory Commission, Washington, DC (United States). Div. of Systems Technology; American Nuclear Society, La Grange Park, IL (United States); American Inst. of Chemical Engineers, New York, NY (United States); American Society of Mechanical Engineers, New York, NY (United States); Canadian Nuclear Society, Toronto, ON (Canada); European Nuclear Society (ENS), Bern (Switzerland); Atomic Energy Society of Japan, Tokyo (Japan); Japan Society of Multiphase Flow, Kyoto (Japan). Sep 1995. (CONF-950904–Vol.3: 7. international meeting on nuclear reactor thermal hydraulics, Saratoga, NY (United States), 10-15 Sep 1995). In *Proceedings of the 7th International Meeting on Nuclear Reactor Thermal-Hydraulics NURETH-7, Volume 3, Sessions 12-16.* 1001p. Source: OSTI; NTIS; INIS; GPO.

The code package SVECHA for the modeling of in-vessel core degradation (CD) phenomena in severe accidents is being developed in the Nuclear Safety Institute, Russian Academy of Science (NSI RAS). The code package presents a detailed mechanistic description of the phenomenology of severe accidents in a reactor core. The modules of the package were developed and validated on separate effect test data. These modules were then successfully implemented in the ICARE2 code and validated against a wide range of integral tests. Validation results have shown good agreement with separate effect tests data and with the integral tests CORA-W1/W2, CORA-13, PHEBUS-B9+.

29721 (NUREG/CP–0142-Vol.3, pp. 1930-1971) **Experimental simulation of the water cooling of corium spread over the floor of a BWR containment.** Morage, F. (Rensselaer Polytechnic Institute, Troy, NY (United States)); Lahey, R.T. Jr.; Podowski, M.Z. Nuclear Regulatory Commission, Washington, DC (United States). Div. of Systems Technology; American Nuclear Society, La Grange Park, IL (United States); American Inst. of Chemical Engineers, New York, NY (United States); American Society of Mechanical Engineers, New York, NY (United States); Canadian Nuclear Society, Toronto, ON (Canada); European Nuclear Society (ENS), Bern (Switzerland); Atomic Energy Society of Japan, Tokyo (Japan); Japan Society of Multiphase Flow, Kyoto (Japan). Sep 1995. (CONF-950904–Vol.3: 7. international meeting on nuclear reactor thermal hydraulics, Saratoga, NY (United States), 10-15 Sep 1995). In *Proceedings of the 7th International Meeting on Nuclear Reactor Thermal-Hydraulics NURETH-7, Volume 3, Sessions 12-16.* 1001p. Source: OSTI; NTIS; INIS; GPO.

This paper is concerned with an experimental investigation of the cooling effect of water collected on the surface of corium released onto the floor of a BWR drywell. In the present experiments, the actual reactor materials were replaced by simulant materials. Specifically, the results are shown for Freon-11 film boiling over liquid Wood's metal spread above a solid porous surface through which argon gas was injected. An analysis of the obtained experimental data revealed that the actual film boiling heat transfer between a molten pool of corium and the water above the pool should be more efficient than predicted by using standard correlations for boiling over solid surfaces. This effect will be further augmented by the gas released due to the ablation of concrete floor beneath the corium and percolating towards its upper surface and into through the water layer above.

29722 (NUREG/CP–0142-Vol.3, pp. 1972-1981) **Numerical simulation of stratified shear flow using a higher order Taylor series expansion method.** Iwashige, Kengo (Hitachi, Ltd. (Japan)); Ikeda, Takashi. Nuclear Regulatory Commission, Washington, DC (United States). Div. of Systems Technology; American Nuclear Society, La Grange Park, IL (United States); American Inst. of Chemical Engineers, New York, NY (United States); American Society of Mechanical Engineers, New York, NY (United States); Canadian Nuclear Society, Toronto, ON (Canada); European Nuclear Society (ENS), Bern (Switzerland); Atomic Energy Society of Japan, Tokyo (Japan); Japan Society of Multiphase Flow, Kyoto (Japan). Sep 1995. (CONF-950904–Vol.3: 7. international meeting on nuclear reactor thermal hydraulics, Saratoga, NY (United States), 10-15 Sep 1995). In *Proceedings of the 7th International Meeting on Nuclear Reactor Thermal-Hydraulics NURETH-7, Volume 3, Sessions 12-16.* 1001p. Source: OSTI; NTIS; INIS; GPO.

A higher order Taylor series expansion method is applied to two-dimensional numerical simulation of stratified shear flow. In the present study, central difference scheme-like method is adopted for an even expansion order, and upwind difference scheme-like method is adopted for an odd order, and the expansion order is variable. To evaluate the effects of expansion order upon the numerical results, a stratified shear flow test in a rectangular channel (Reynolds number = 1.7×10^4) is carried out, and the numerical velocity and temperature fields are compared with experimental results measured by laser Doppler velocimetry thermocouples. The results confirm that the higher and odd order methods can simulate mean velocity distributions, root-mean-square velocity fluctuations, Reynolds stress, temperature distributions, and root-mean-square temperature fluctuations.

29723 (NUREG/CP–0142-Vol.3, pp. 1982-1996) **Application of an analytical method for solution of thermal hydraulic conservation equations.** Fakory, M.R. (Simulation, Systems & Services Technologies Company (S3 Technologies), Columbia, MD (United States)). Nuclear Regulatory Commission, Washington, DC (United States). Div. of Systems Technology; American Nuclear Society, La Grange Park, IL (United States); American Inst. of Chemical Engineers, New York, NY (United States); American Society of Mechanical Engineers, New York, NY (United States); Canadian Nuclear Society, Toronto, ON (Canada); European Nuclear Society (ENS), Bern (Switzerland); Atomic Energy Society of Japan, Tokyo (Japan); Japan Society of Multiphase Flow, Kyoto (Japan). Sep 1995. (CONF-950904–Vol.3: 7. international meeting on nuclear reactor thermal hydraulics, Saratoga, NY (United States), 10-15 Sep 1995). In *Proceedings of the 7th International Meeting on Nuclear Reactor Thermal-Hydraulics NURETH-7, Volume 3, Sessions 12-16.* 1001p. Source: OSTI; NTIS; INIS; GPO.

An analytical method has been developed and applied for solution of two-phase flow conservation equations. The test results for application of the model for simulation of BWR transients are presented and compared with the results obtained from application of the explicit method for integration of conservation equations. The test results show that with application of the analytical method for integration of conservation equations, the Courant limitation associated with explicit Euler method of integration was eliminated. The results obtained from application of the analytical method (with large time steps) agreed well with the results obtained from application of explicit method of integration (with time steps smaller than the size imposed by Courant limitation). The results demonstrate that application of the analytical approach significantly improves the numerical stability and computational efficiency.

29724 (NUREG/CP–0142-Vol.3, pp. 1997-2002) **Numerical investigation of heat transfer in high-temperature gas-cooled reactors.** Chen, g. (Univ. of Florida, Gainesville, FL (United States)); Anghaie, S. Nuclear Regulatory Commission, Washington, DC (United States). Div. of Systems Technology; American Nuclear Society, La Grange Park, IL (United States); American Inst. of

Chemical Engineers, New York, NY (United States); American Society of Mechanical Engineers, New York, NY (United States); Canadian Nuclear Society, Toronto, ON (Canada); European Nuclear Society (ENS). Bern (Switzerland); Atomic Energy Society of Japan, Tokyo (Japan); Japan Society of Multiphase Flow, Kyoto (Japan). Sep 1995. Contract NAS3-26314. (CONF-950904–Vol.3: 7. international meeting on nuclear reactor thermal hydraulics, Saratoga, NY (United States), 10-15 Sep 1995). In *Proceedings of the 7th International Meeting on Nuclear Reactor Thermal-Hydraulics NURETH-7, Volume 3, Sessions 12-16.* 1001p. Source: OSTI; NTIS; INIS; GPO.

This paper proposes a computational model for analysis of flow and heat transfer in high-temperature gas-cooled reactors. The formulation of the problem is based on using the axisymmetric, thin layer Navier-Stokes equations. A hybrid implicit-explicit method based on finite volume approach is used to numerically solve the governing equations. A fast converging scheme is developed to accelerate the Gauss-Siedel iterative method for problems involving the wall heat flux boundary condition. Several cases are simulated and results of temperature and pressure distribution in the core are presented. Results of a parametric analysis for the assessment of the impact of power density on the convective heat transfer rate and wall temperature are discussed. A comparative analysis is conducted to identify the Nusselt number correlation that best fits the physical conditions of the high-temperature gas-cooled reactors.

29725 (NUREG/CP–0142-Vol.3, pp. 2003-2010) **Development of a graphical user interface for the TRAC plant/safety analysis code.** Kelly, A.E.; Harkins, C.K.; Smith, R.J. Nuclear Regulatory Commission, Washington, DC (United States). Div. of Systems Technology; American Nuclear Society, La Grange Park, IL (United States); American Inst. of Chemical Engineers, New York, NY (United States); American Society of Mechanical Engineers, New York, NY (United States); Canadian Nuclear Society, Toronto, ON (Canada); European Nuclear Society (ENS), Bern (Switzerland); Atomic Energy Society of Japan, Tokyo (Japan); Japan Society of Multiphase Flow, Kyoto (Japan). Sep 1995. (CONF-950904–Vol.3: 7. international meeting on nuclear reactor thermal hydraulics, Saratoga, NY (United States), 10-15 Sep 1995). In *Proceedings of the 7th International Meeting on Nuclear Reactor Thermal-Hydraulics NURETH-7, Volume 3, Sessions 12-16.* 1001p. Source: OSTI; NTIS; INIS; GPO.

A graphical user interface (GUI) for the Transient Reactor Analysis Code (TRAC) has been developed at Knolls Atomic Power Laboratory. This X Window based GUI supports the design and analysis process, acting as a preprocessor, runtime editor, help system and post processor to TRAC-PF1/MOD2. TRAC was developed at the Los Alamos National Laboratory (LANL). The preprocessor is an icon-based interface which allows the user to create a TRAC model. When the model is complete, the runtime editor provides the capability to execute and monitor TRAC runs on the workstation or supercomputer. After runs are made, the output processor allows the user to extract and format data from the TRAC graphics file. The TRAC GUI is currently compatible with TRAC-PF1/MOD2 V5.3 and is available with documentation from George Niederauer, Section Leader of the Software Development Section, Group TSA-8, at LANL. Users may become functional in creating, running, and interpreting results from TRAC without having to know Unix commands and the detailed format of any of the data files. This reduces model development and debug time and increases quality control. Integration with post-processing and visualization tools increases engineering effectiveness.

29726 (NUREG/CP–0142-Vol.3, pp. 2011-2020) **A comparison of the effect of the first and second upwind schemes on the predictions of the modified RELAP5/MOD3.** Analytis, G.Th. (Paul Scherrer Institute (PSI), Villigen (Switzerland)). Nuclear Regulatory Commission, Washington, DC (United States). Div. of Systems Technology; American Nuclear Society, La Grange Park, IL (United States); American Inst. of Chemical Engineers, New York, NY (United States); American Society of Mechanical Engineers, New York, NY (United States); Canadian Nuclear Society, Toronto, ON (Canada); European Nuclear Society (ENS), Bern (Switzerland); Atomic Energy Society of Japan, Tokyo (Japan); Japan Society of Multiphase Flow, Kyoto (Japan). Sep 1995. (CONF-950904–Vol.3: 7. international meeting on nuclear reactor thermal hydraulics, Saratoga, NY (United States), 10-15 Sep 1995). In *Proceedings of the 7th International Meeting on Nuclear Reactor Thermal-Hydraulics NURETH-7, Volume 3, Sessions 12-16.* 1001p. Source: OSTI; NTIS; INIS; GPO.

As is well-known, both TRAC-BF1 and TRAC-PF are using the first upwind scheme when finite-differencing the phasic momentum equations. In contrast, RELAP5 uses the second upwind which is less diffusive. In this work, we shall assess the differences between the two schemes with our modified version of RELAP5/MOD3 by analyzing some transients of interest. These will include the LOFT LP-LB-1 and LOBI small break LOCA (SB-LOCA) BL34 tests, and a commercial PWR 200% hypothetical large break LOCA (LB-LOCA). In particular, we shall show that for some of these transients, the employment of the first upwind scheme results in significantly different code predictions than the ones obtained when the second upwind scheme is used.

29727 (NUREG/CP–0142-Vol.3, pp. 2035-2044) **Level tracking in detailed reactor simulations.** Aktas, B. (Pennsylvania State Univ., University Park, PA (United States)); Mahaffy, J.H. Nuclear Regulatory Commission, Washington, DC (United States). Div. of Systems Technology; American Nuclear Society, La Grange Park, IL (United States); American Inst. of Chemical Engineers, New York, NY (United States); American Society of Mechanical Engineers, New York, NY (United States); Canadian Nuclear Society, Toronto, ON (Canada); European Nuclear Society (ENS), Bern (Switzerland); Atomic Energy Society of Japan, Tokyo (Japan); Japan Society of Multiphase Flow, Kyoto (Japan). Sep 1995. (CONF-950904–Vol.3: 7. international meeting on nuclear reactor thermal hydraulics, Saratoga, NY (United States), 10-15 Sep 1995). In *Proceedings of the 7th International Meeting on Nuclear Reactor Thermal-Hydraulics NURETH-7, Volume 3, Sessions 12-16.* 1001p. Source: OSTI; NTIS; INIS; GPO.

We introduce a useful test problem for judging the performance of reactor safety codes in situations where moving two-phase mixture levels are present. The test problem tracks a two-phase liquid level as it rises and then falls back to its original position. Pure air exists above the level, and a low void air-water mixture is below the level. Conditions are subcooled and isothermal to remove complications resulting from failures of interfacial heat transfer packages to properly account for the level. Comparisons are made between the performance of current versions of CATHARE, RELAP5, TRAC-BF1, and TRAC-PF1. These system codes are based on finite-difference methods with a fixed, Eulerian staggered grid in space. When a partially filled cell with a mixture level discontinuity becomes the donor cell, the sharp changes in fluid properties across the interface results in numerical oscillations of various terms. Furthermore, the cell-to-cell convection of mass, momentum and energy are inaccurately predicted nearby a mixture level. To adequately model moving mixture levels, an efficient discontinuity tracking method for the finite-difference Eulerian approximations is described. This model had been implemented in the TRAC-BWR code for the two-phase mixture level tracking since the TRAC-BD1 Version (released April 1984). The result of the test problem run by the current version of TRAC-BF1/MOD1 with the mixture level tracking model shows some peculiar behavior of the variables such as velocities, pressures and interfacial terms. A systematic approach to improving performance of the tracking method is described. Implementing this approach in TRAC-BF1/MOD1 has shown a major improvement in the results.

29728 (NUREG/CP–0142-Vol.3, pp. 2045-2066) **The sensitivity analysis by adjoint method for the uncertainty evaluation of the CATHARE-2 code.** Barre, F. (French Atomic Energy Commission (CEA), Grenoble (France)); de Crecy, A.; Perret, C. Nuclear Regulatory Commission, Washington, DC (United States). Div. of Systems Technology; American Nuclear Society, La Grange Park, IL (United States); American Inst. of Chemical Engineers, New York, NY (United States); American Society of Mechanical Engineers, New York, NY (United States); Canadian Nuclear Society, Toronto, ON (Canada); European Nuclear Society (ENS), Bern (Switzerland); Atomic Energy Society of Japan, Tokyo (Japan); Japan Society of Multiphase Flow, Kyoto (Japan). Sep 1995. (CONF-950904–Vol.3: 7. international meeting on nuclear reactor

thermal hydraulics, Saratoga, NY (United States), 10-15 Sep 1995). In *Proceedings of the 7th International Meeting on Nuclear Reactor Thermal-Hydraulics NURETH-7, Volume 3, Sessions 12-16.* 1001p. Source: OSTI; NTIS; INIS; GPO.

This paper presents the application of the DASM (Discrete Adjoint Sensitivity Method) to CATHARE 2 thermal-hydraulics code. In a first part, the basis of this method is presented. The mathematical model of the CATHARE 2 code is based on the two fluid six equation model. It is discretized using implicit time discretization and it is relatively easy to implement this method in the code. The DASM is the ASM directly applied to the algebraic system of the discretized code equations which has been demonstrated to be the only solution of the mathematical model. The ASM is an integral part of the new version 1.4 of CATHARE. It acts as a post-processing module. It has been qualified by comparison with the "brute force" technique. In a second part, an application of the DASM in CATHARE 2 is presented. It deals with the determination of the uncertainties of the constitutive relationships, which is a compulsory step for calculating the final uncertainty of a given response. First, the general principles of the method are explained: the constitutive relationship are represented by several parameters and the aim is to calculate the variance-covariance matrix of these parameters. The experimental results of the separate effect tests used to establish the correlation are considered. The variance of the corresponding results calculated by CATHARE are estimated by comparing experiment and calculation. A DASM calculation is carried out to provide the derivatives of the responses. The final covariance matrix is obtained by combination of the variance of the responses and those derivatives. Then, the application of this method to a simple case-the blowdown Canon experiment-is presented. This application has been successfully performed.

29729 (NUREG/CP–0142-Vol.3, pp. 2067-2078) **Development and assessment of a modified version of RELAP5/MOD3.** Analytis, G.T. (Paul Scherrer Institute, Villigen (Switzerland)). Nuclear Regulatory Commission, Washington, DC (United States). Div. of Systems Technology; American Nuclear Society, La Grange Park, IL (United States); American Inst. of Chemical Engineers, New York, NY (United States); American Society of Mechanical Engineers, New York, NY (United States); Canadian Nuclear Society, Toronto, ON (Canada); European Nuclear Society (ENS), Bern (Switzerland); Atomic Energy Society of Japan, Tokyo (Japan); Japan Society of Multiphase Flow, Kyoto (Japan). Sep 1995. (CONF-950904–Vol.3: 7. international meeting on nuclear reactor thermal hydraulics, Saratoga, NY (United States), 10-15 Sep 1995). In *Proceedings of the 7th International Meeting on Nuclear Reactor Thermal-Hydraulics NURETH-7, Volume 3, Sessions 12-16.* 1001p. Source: OSTI; NTIS; INIS; GPO.

A summary of a number of modifications introduced in RELAP/MOD3 is presented. These include implementation of different heat transfer packages for different processes, modification of the low mass-flux Groeneveld CHF look-up table and of the dispersed flow interfacial area (and shear) as well as of the criterion for transition into and out from this regime, elimination of the under-relaxation schemes of the interfacial closure coefficients etc. The modified code is assessed against a number of separate-effect and integral test experiments and in contrast to the frozen version, is shown to result in physically sound predictions which are close to the measurements.

29730 (NUREG/CP–0142-Vol.3, pp. 2079-2101) **A study of the dispersed flow interfacial heat transfer model of RELAP5/MOD2.5 and RELAP5/MOD3.** Andreani, M. (Swiss Federal Institute of Technology, Zurich (Switzerland)); Analytis, G.T.; Aksan, S.N. Nuclear Regulatory Commission, Washington, DC (United States). Div. of Systems Technology; American Nuclear Society, La Grange Park, IL (United States); American Inst. of Chemical Engineers, New York, NY (United States); American Society of Mechanical Engineers, New York, NY (United States); Canadian Nuclear Society, Toronto, ON (Canada); European Nuclear Society (ENS), Bern (Switzerland); Atomic Energy Society of Japan, Tokyo (Japan); Japan Society of Multiphase Flow, Kyoto (Japan). Sep 1995. (CONF-950904–Vol.3: 7. international meeting on nuclear reactor thermal hydraulics, Saratoga, NY (United States), 10-15 Sep 1995). In *Proceedings of the 7th International Meeting on Nuclear Reactor Thermal-Hydraulics NURETH-7, Volume 3, Sessions 12-16.* 1001p. Source: OSTI; NTIS; INIS; GPO.

The model of interfacial heat transfer for the dispersed flow regime used in the RELAP5 computer codes is investigated in the present paper. Short-transient calculations of two low flooding rate tube reflooding experiments have been performed, where the hydraulic conditions and the heat input to the vapour in the post-dryout region were controlled for the predetermined position of the quench front. Both RELAP5/MOD2.5 and RELAP5/MOD3 substantially underpredicted the exit vapour temperature. The mass flow rate and quality, however, were correct and the heat input to the vapour was larger than the actual one. As the vapour superheat at the tube exit depends on the balance between the heat input from the wall and the heat exchange with the droplets, the discrepancy between the calculated and the measured exit vapour temperature suggested that the inability of both codes to predict the vapour superheat in the dispersed flow region is due to the overprediction of the interfacial heat transfer rate.

29731 (NUREG/CP–0142-Vol.3, pp. 2102-2111) **Assessment of computer codes for VVER-440/213-type nuclear power plants.** Szabados, L. (Atomic Energy Research Institute, Budapest (Hungary)); Ezsol, Gy.; Perneczky. Nuclear Regulatory Commission, Washington, DC (United States). Div. of Systems Technology; American Nuclear Society, La Grange Park, IL (United States); American Inst. of Chemical Engineers, New York, NY (United States); American Society of Mechanical Engineers, New York, NY (United States); Canadian Nuclear Society, Toronto, ON (Canada); European Nuclear Society (ENS), Bern (Switzerland); Atomic Energy Society of Japan, Tokyo (Japan); Japan Society of Multiphase Flow, Kyoto (Japan). Sep 1995. (CONF-950904–Vol.3: 7. international meeting on nuclear reactor thermal hydraulics, Saratoga, NY (United States), 10-15 Sep 1995). In *Proceedings of the 7th International Meeting on Nuclear Reactor Thermal-Hydraulics NURETH-7, Volume 3, Sessions 12-16.* 1001p. Source: OSTI; NTIS; INIS; GPO.

Nuclear power plant of VVER-440/213 designed by the former USSR have a number of special features. As a consequence of these features the transient behaviour of such a reactor system should be different from the PWR system behaviour. To study the transient behaviour of the Hungarian Paks Nuclear Power Plant of VVER-440/213-type both analytical and experimental activities have been performed. The experimental basis of the research in the PMK-2 integral-type test facility , which is a scaled down model of the plant. Experiments performed on this facility have been used to assess thermal-hydraulic system codes. Four tests were selected for "Standard Problem Exercises" of the International Atomic Energy Agency. Results of the 4th Exercise, of high international interest, are presented in the paper, focusing on the essential findings of the assessment of computer codes.

29732 (NUREG/CP–0142-Vol.3, pp. 2112-2118) **VIPRE modeling of VVER-1000 reactor core for DNB analyses.** Sung, Y. (Westinghouse Electric Corporation, Pittsburgh, PA (United States)); Nguyen, Q.; Cizek, J. Nuclear Regulatory Commission, Washington, DC (United States). Div. of Systems Technology; American Nuclear Society, La Grange Park, IL (United States); American Inst. of Chemical Engineers, New York, NY (United States); American Society of Mechanical Engineers, New York, NY (United States); Canadian Nuclear Society, Toronto, ON (Canada); European Nuclear Society (ENS), Bern (Switzerland); Atomic Energy Society of Japan, Tokyo (Japan); Japan Society of Multiphase Flow, Kyoto (Japan). Sep 1995. (CONF-950904–Vol.3: 7. international meeting on nuclear reactor thermal hydraulics, Saratoga, NY (United States), 10-15 Sep 1995). In *Proceedings of the 7th International Meeting on Nuclear Reactor Thermal-Hydraulics NURETH-7, Volume 3, Sessions 12-16.* 1001p. Source: OSTI; NTIS; INIS; GPO.

Based on the one-pass modeling approach, the hot channels and the VVER-1000 reactor core can be modeled in 30 channels for DNB analyses using the VIPRE-01/MOD02 (VIPRE) code (VIPRE is owned by Electric Power Research Institute, Palo Alto, California). The VIPRE one-pass model does not compromise any accuracy in the hot channel local fluid conditions. Extensive qualifications include sensitivity studies of radial noding and crossflow

parameters and comparisons with the results from THINC and CALOPEA subchannel codes. The qualifications confirm that the VIPRE code with the Westinghouse modeling method provides good computational performance and accuracy for VVER-1000 DNB analyses.

29733 (NUREG/CP–0142-Vol.3, pp. 2119-2145) **CATHARE2 calculation of SPE-3 test small break loca on PMK facility.** Laugier, E. (Institut de Protection et de Surete Nucleaire, Cadarache (France)); Radet, J. Nuclear Regulatory Commission, Washington, DC (United States). Div. of Systems Technology; American Nuclear Society, La Grange Park, IL (United States); American Inst. of Chemical Engineers, New York, NY (United States); American Society of Mechanical Engineers, New York, NY (United States); Canadian Nuclear Society, Toronto, ON (Canada); European Nuclear Society (ENS), Bern (Switzerland); Atomic Energy Society of Japan, Tokyo (Japan); Japan Society of Multiphase Flow, Kyoto (Japan). Sep 1995. (CONF-950904–Vol.3: 7. international meeting on nuclear reactor thermal hydraulics, Saratoga, NY (United States), 10-15 Sep 1995). In *Proceedings of the 7th International Meeting on Nuclear Reactor Thermal-Hydraulics NURETH-7, Volume 3, Sessions 12-16.* 1001p. Source: OSTI; NTIS; INIS; GPO.

Bind and post test calculations with CATHARE2 have been performed concerning the SPE-4 exercise organized under the auspices of IAEA on the hungarian PMK-2 facility, a one loop scaled model of VVER 440/213 Nuclear Power Plant. The SPE-4 test is a cold leg SBLOCA associated to a "bleed and feed" procedure applied in the secondary circuit. The present paper is devoted to the analysis of the post test calculation. For the first part of the transient (until the end of the SIT activations), the primary and secondary pressures are rather well predicted, leading to a good agreement with the experimental trips, as scram, flow coast down, SIT beginning and end of activation. Nevertheless, some discrepancy with the experiment may be due to an over prediction of the thermal exchanges from the primary to the secondary circuits. For the second part of the transient, the predicted primary circuit repressurization is shifted after the SITs are off, while in the experiment this event immediately follows the end of SIT activation. The delay in the calculation leads to underpredict primary and secondary pressures, thus anticipating the timing of events, such as LPIS and emergency feedwater activation.

29734 (NUREG/CP–0142-Vol.3, pp. 2146-2158) **Quantitative code accuracy evaluation of ISP33.** Kalli, H. (Lappeenranta Univ. of Technology (Finland)); Miwrrin, A.; Purhonen, H. Nuclear Regulatory Commission, Washington, DC (United States). Div. of Systems Technology; American Nuclear Society, La Grange Park, IL (United States); American Inst. of Chemical Engineers, New York, NY (United States); American Society of Mechanical Engineers, New York, NY (United States); Canadian Nuclear Society, Toronto, ON (Canada); European Nuclear Society (ENS), Bern (Switzerland); Atomic Energy Society of Japan, Tokyo (Japan); Japan Society of Multiphase Flow, Kyoto (Japan). Sep 1995. (CONF-950904–Vol.3: 7. international meeting on nuclear reactor thermal hydraulics, Saratoga, NY (United States), 10-15 Sep 1995). In *Proceedings of the 7th International Meeting on Nuclear Reactor Thermal-Hydraulics NURETH-7, Volume 3, Sessions 12-16.* 1001p. Source: OSTI; NTIS; INIS; GPO.

Aiming at quantifying code accuracy, a methodology based on the Fast Fourier Transform has been developed at the University of Pisa, Italy. The paper deals with a short presentation of the methodology and its application to pre-test and post-test calculations submitted to the International Standard Problem ISP33. This was a double-blind natural circulation exercise with a stepwise reduced primary coolant inventory, performed in PACTEL facility in Finland. PACTEL is a 1/305 volumetrically scaled, full-height simulator of the Russian type VVER-440 pressurized water reactor, with horizontal steam generators and loop seals in both cold and hot legs. Fifteen foreign organizations participated in ISP33, with 21 blind calculations and 20 post-test calculations, altogether 10 different thermal hydraulic codes and code versions were used. The results of the application of the methodology to nine selected measured quantities are summarized.

29735 (NUREG/CP–0142-Vol.3, pp. 2159-2168) **FARO base case post-test analysis by COMETA code.** Annunziato, A. (Joint Research Centre, Ispra (Italy)); Addabbo, C. Nuclear Regulatory Commission, Washington, DC (United States). Div. of Systems Technology; American Nuclear Society, La Grange Park, IL (United States); American Inst. of Chemical Engineers, New York, NY (United States); American Society of Mechanical Engineers, New York, NY (United States); Canadian Nuclear Society, Toronto, ON (Canada); European Nuclear Society (ENS), Bern (Switzerland); Atomic Energy Society of Japan, Tokyo (Japan); Japan Society of Multiphase Flow, Kyoto (Japan). Sep 1995. (CONF-950904–Vol.3: 7. international meeting on nuclear reactor thermal hydraulics, Saratoga, NY (United States), 10-15 Sep 1995). In *Proceedings of the 7th International Meeting on Nuclear Reactor Thermal-Hydraulics NURETH-7, Volume 3, Sessions 12-16.* 1001p. Source: OSTI; NTIS; INIS; GPO.

The paper analyzes the COMETA (Core Melt Thermal-Hydraulic Analysis) post test calculations of FARO Test L-11, the so-called Base Case Test. The FARO Facility, located at JRC Ispra, is used to simulate the consequences of Severe Accidents in Nuclear Power Plants under a variety of conditions. The COMETA Code has a 6 equations two phase flow field and a 3 phases corium field: the jet, the droplets and the fused-debris bed. The analysis shown that the code is able to pick-up all the major phenomena occurring during the fuel-coolant interaction pre-mixing phase.

29736 (NUREG/CP–0142-Vol.3, pp. 2185-2202) **An assessment of RELAP5 MOD3.1.1 condensation heat transfer modeling with GIRAFFE heat transfer tests.** Boyer, B.D. (and others); Parlatan, Y.; Slovik, G.C. Nuclear Regulatory Commission, Washington, DC (United States). Div. of Systems Technology; American Nuclear Society, La Grange Park, IL (United States); American Inst. of Chemical Engineers, New York, NY (United States); American Society of Mechanical Engineers, New York, NY (United States); Canadian Nuclear Society, Toronto, ON (Canada); European Nuclear Society (ENS), Bern (Switzerland); Atomic Energy Society of Japan, Tokyo (Japan); Japan Society of Multiphase Flow, Kyoto (Japan). Sep 1995. (CONF-950904–Vol.3: 7. international meeting on nuclear reactor thermal hydraulics, Saratoga, NY (United States), 10-15 Sep 1995). In *Proceedings of the 7th International Meeting on Nuclear Reactor Thermal-Hydraulics NURETH-7, Volume 3, Sessions 12-16.* 1001p. Source: OSTI; NTIS; INIS; GPO.

RELAP5 MOD3.1.1 is being used to simulate Loss of Coolant Accidents (LOCA) for the Simplified Boiling Water Reactor (SBWR) being proposed by General Electric (GE). One of the major components associated with the SBWR is the Passive Containment Cooling System (PCCS) which provides the long-term heat sink to reject decay heat. The RELAP5 MOD3.1.1 code is being assessed for its ability to represent accurately the PCCS. Data from the Phase 1, Step 1 Heat Transfer Tests performed at Toshiba's Gravity-Driven Integral Full-Height Test for Passive Heat Removal (GIRAFFE) facility will be used for assessing the ability of RELAP5 to model condensation in the presence of noncondensables. The RELAP5 MOD3.1.1 condensation model uses the University of California at Berkeley (UCB) correlation developed by Vierow and Schrock. The RELAP5 code uses this heat transfer coefficient with the gas velocity effect multiplier being limited to 2. This heat transfer option was used to analyze the condensation heat transfer in the GIRAFFE PCCS heat exchanger tubes in the Phase 1, Step 1 Heat Transfer Tests which were at a pressure of 3 bar and had a range of nitrogen partial pressure fractions from 0.0 to 0.10. The results of a set of RELAP5 calculations at these conditions were compared with the GIRAFFE data. The effects of PCCS cell noding on the heat transfer process were also studied. The UCB correlation, as implemented in RELAP5, predicted the heat transfer to ±5% of the data with a three–node model. The three-node model has a large cell in the entrance region which smeared out the entrance effects on the heat transfer, which tend to overpredict the condensation. Hence, the UCB correlation predicts condensation heat transfer correlation implemented in the code must be removed to allow for accurate calculations with smaller cell sizes.

29737 (NUREG/CP–0142-Vol.3, pp. 2203-2221) **ATHLET validation using accident management experiments.** Teschendorff,

V. (Gasellschaft fuer Anlagen - und Reaktorsicherheit (GSR) mbH, Garching (Germany)); Glaeser, H.; Steinhoff, F. Nuclear Regulatory Commission, Washington, DC (United States). Div. of Systems Technology; American Nuclear Society, La Grange Park, IL (United States); American Inst. of Chemical Engineers, New York, NY (United States); American Society of Mechanical Engineers, New York, NY (United States); Canadian Nuclear Society, Toronto, ON (Canada); European Nuclear Society (ENS), Bern (Switzerland); Atomic Energy Society of Japan, Tokyo (Japan); Japan Society of Multiphase Flow, Kyoto (Japan). Sep 1995. (CONF-950904–Vol.3: 7. international meeting on nuclear reactor thermal hydraulics, Saratoga, NY (United States), 10-15 Sep 1995). In *Proceedings of the 7th International Meeting on Nuclear Reactor Thermal-Hydraulics NURETH-7, Volume 3, Sessions 12-16.* 1001p. Source: OSTI; NTIS; INIS; GPO.

The computer code ATHLET is being developed as an advanced best-estimate code for the simulation of leaks and transients in PWRs and BWRs including beyond design basis accidents. The code has features that are of special interest for applications to small leaks and transients with accident management, e.g. initialisation by a steady-state calculation, full-range drift-flux model, and dynamic mixture level tracking. The General Control Simulation Module of ATHLET is a flexible tool for the simulation of the balance-of-plant and control systems including the various operator actions in the course of accident sequences with AM measures. The systematic validation of ATHLET is based on a well balanced set of integral and separate effect tests derived from the CSNI proposal emphasising, however, the German combined ECC injection system which was investigated in the UPTF, PKL and LOBI test facilities. PKL-III test B 2.1 simulates a cool-down procedure during an emergency power case with three steam generators isolated. Natural circulation under these conditions was investigated in detail in a pressure range of 4 to 2 MPa. The transient was calculated over 22000 s with complicated boundary conditions including manual control actions. The calculations demonstrations the capability to model the following processes successfully: (1) variation of the natural circulation caused by steam generator isolation, (2) vapour formation in the U-tubes of the isolated steam generators, (3) break-down of circulation in the loop containing the isolated steam generator following controlled cool-down of the secondary side, (4) accumulation of vapour in the pressure vessel dome. One conclusion with respect to the suitability of experiments simulating AM procedures for code validation purposes is that complete documentation of control actions during the experiment must be available. Special attention should be given to the documentation of operator actions in the course of the experiment.

29738 (NUREG/CP–0142-Vol.3, pp. 2222-2239) **A simple modelling of mass diffusion effects on condensation with non-condensable gases for the CATHARE Code.** Coste, P. (Commissariat a l Energie Atomique, Grenoble (France)); Bestion, D. Nuclear Regulatory Commission, Washington, DC (United States). Div. of Systems Technology; American Nuclear Society, La Grange Park, IL (United States); American Inst. of Chemical Engineers, New York, NY (United States); American Society of Mechanical Engineers, New York, NY (United States); Canadian Nuclear Society, Toronto, ON (Canada); European Nuclear Society (ENS), Bern (Switzerland); Atomic Energy Society of Japan, Tokyo (Japan); Japan Society of Multiphase Flow, Kyoto (Japan). Sep 1995. (CONF-950904–Vol.3: 7. international meeting on nuclear reactor thermal hydraulics, Saratoga, NY (United States), 10-15 Sep 1995). In *Proceedings of the 7th International Meeting on Nuclear Reactor Thermal-Hydraulics NURETH-7, Volume 3, Sessions 12-16.* 1001p. Source: OSTI; NTIS; INIS; GPO.

This paper presents a simple modelling of mass diffusion effects on condensation. In presence of noncondensable gases, the mass diffusion near the interface is modelled using the heat and mass transfer analogy and requires normally an iterative procedure to calculate the interface temperature. Simplifications of the model and of the solution procedure are used without important degradation of the predictions. The model is assessed on experimental data for both film condensation in vertical tubes and direct contact condensation in horizontal tubes, including air-steam, Nitrogen-steam and Helium-steam data. It is implemented in the Cathare code, a french system code for nuclear reactor thermal hydraulics developed by CEA, EDF, and FRAMATOME.

29739 (NUREG/CP–0142-Vol.3, pp. 2256-2262) **Some thermohydraulics of closure head adapters in a 3 loops PWR.** Hoffmann, F. (EDF/DER/National Hydraulics Laboratory, Chatou (France)); Daubert, O.; Hecker, M. Nuclear Regulatory Commission, Washington, DC (United States). Div. of Systems Technology; American Nuclear Society, La Grange Park, IL (United States); American Inst. of Chemical Engineers, New York, NY (United States); American Society of Mechanical Engineers, New York, NY (United States); Canadian Nuclear Society, Toronto, ON (Canada); European Nuclear Society (ENS), Bern (Switzerland); Atomic Energy Society of Japan, Tokyo (Japan); Japan Society of Multiphase Flow, Kyoto (Japan). Sep 1995. (CONF-950904–Vol.3: 7. international meeting on nuclear reactor thermal hydraulics, Saratoga, NY (United States), 10-15 Sep 1995). In *Proceedings of the 7th International Meeting on Nuclear Reactor Thermal-Hydraulics NURETH-7, Volume 3, Sessions 12-16.* 1001p. Source: OSTI; NTIS; INIS; GPO.

In 1993 a R&D action, based on numerical simulations and experiments on PWR's upper head was initiated. This paper presents the test facility TRAVERSIN (a scale model of a 900 MW PWR adapter) and the calculations performed on the geometry of different upper head sections with the Thermalhydraulic Finite Element Code N3S used for 2D and 3D computations. The paper presents the method followed to bring the adapter and upper head study to a successful conclusion. Two complementary approaches are performed to obtain global results on complete fluid flow in the upper head and local results on the flow around the adapters of closure head. A validation test case of these experimental and numerical tools is also presented.

29740 (NUREG/CP–0142-Vol.3, pp. 2263-2279) **Analysis of a small break loss-of-coolant accident of pressurized water reactor by APROS.** Al-Falahi, A. (Helsinki Univ. of Technology, Espoo (Finland)); Haennine, M.; Porkholm, K. Nuclear Regulatory Commission, Washington, DC (United States). Div. of Systems Technology; American Nuclear Society, La Grange Park, IL (United States); American Inst. of Chemical Engineers, New York, NY (United States); American Society of Mechanical Engineers, New York, NY (United States); Canadian Nuclear Society, Toronto, ON (Canada); European Nuclear Society (ENS), Bern (Switzerland); Atomic Energy Society of Japan, Tokyo (Japan); Japan Society of Multiphase Flow, Kyoto (Japan). Sep 1995. (CONF-950904–Vol.3: 7. international meeting on nuclear reactor thermal hydraulics, Saratoga, NY (United States), 10-15 Sep 1995). In *Proceedings of the 7th International Meeting on Nuclear Reactor Thermal-Hydraulics NURETH-7, Volume 3, Sessions 12-16.* 1001p. Source: OSTI; NTIS; INIS; GPO.

The purpose of this paper is to study the capability of APROS (Advanced PROcess Simulator) code to simulate the real plant thermal-hydraulic transient of a Small Break Loss-Of-Coolant Accident (SBLOCA) of Loss-Of-Fluid Test (LOFT) facility. The LOFT is a scaled model of a Pressurized Water Reactor (PWR). This work is a part of a larger validation of the APROS thermal-hydraulic models. The results of SBLOCA transient calculated by APROS showed a reasonable agreement with the measured data.

29741 (NUREG/CP–0142-Vol.3, pp. 2280-2302) **Evaluation and assessment of reflooding models in RELAP5/Mod2.5 and RELAP5/Mod3 codes using Lehigh University and PSI-Neptun bundle experimental data.** Sencar, M. (Paul Scherrer Institute, Villigen (Switzerland)); Aksan, N. Nuclear Regulatory Commission, Washington, DC (United States). Div. of Systems Technology; American Nuclear Society, La Grange Park, IL (United States); American Inst. of Chemical Engineers, New York, NY (United States); American Society of Mechanical Engineers, New York, NY (United States); Canadian Nuclear Society, Toronto, ON (Canada); European Nuclear Society (ENS), Bern (Switzerland); Atomic Energy Society of Japan, Tokyo (Japan); Japan Society of Multiphase Flow, Kyoto (Japan). Sep 1995. (CONF-950904–Vol.3: 7. international meeting on nuclear reactor thermal hydraulics, Saratoga, NY (United States), 10-15 Sep 1995). In *Proceedings of the 7th International Meeting on Nuclear Reactor Thermal-Hydraulics*

NURETH-7, Volume 3, Sessions 12-16. 1001p. Source: OSTI; NTIS; INIS; GPO.

An extensive analysis and assessment work on reflooding models of RELAP5/Mod2.5 and, RELAP5/Mod3/v5m5 and RELAP/Mod3/v7j have been performed. Experimental data from LehighUniversityv. and PSI-NEPTUN bundle reflooding experiments have been used for the assessment, since both of these tests cover a broad range of initial conditions. Within the range of these initial conditions, it was tried to identify their separate impacts on the calculated results. A total of six Lehigh University reflooding bundle tests and two PSI-NEPTUN tests with bounding initial conditions are selected for the analysis. Detailed nodalisation studies both for hydraulic and conduction heat transfer were done. On the basis of the results obtained from these cases, a base nodalisation scheme was established. All the other analysis work was performed by using this base nodalisation. RELAP5/Mod2.5 results do not change with renodalisation but RELAP5/Mod3 results are more sensitive to renodalisation. The results of RELAP5/Mod2.5 versions show very large deviations from the used experimental data. These results indicate that some of the phenomenology of the events occurring during the reflooding could not be identified. In the paper, detailed discussions on the main reasons of the deviations from the experimental data will be presented. Since, the results and findings of this study are meant to be a developmental aid, some recommendations have been drawn and some of these have already been implemented at PSI with promising results.

29742 (NUREG/CP–0142-Vol.3, pp. 2303-2324) **Overview of CSNI separate effects tests validation matrix.** Aksan, N. (Paul Scherrer Institute, Villigen (Switzerland)); Auria, F.D.; Glaeser, H. Nuclear Regulatory Commission, Washington, DC (United States). Div. of Systems Technology; American Nuclear Society, La Grange Park, IL (United States); American Inst. of Chemical Engineers, New York, NY (United States); American Society of Mechanical Engineers, New York, NY (United States); Canadian Nuclear Society, Toronto, ON (Canada); European Nuclear Society (ENS), Bern (Switzerland); Atomic Energy Society of Japan, Tokyo (Japan); Japan Society of Multiphase Flow, Kyoto (Japan). Sep 1995. (CONF-950904–Vol.3: 7. international meeting on nuclear reactor thermal hydraulics, Saratoga, NY (United States), 10-15 Sep 1995). In *Proceedings of the 7th International Meeting on Nuclear Reactor Thermal-Hydraulics NURETH-7, Volume 3, Sessions 12-16.* 1001p. Source: OSTI; NTIS; INIS; GPO.

An internationally agreed separate effects test (SET) Validation Matrix for thermal-hydraulic system codes has been established by a sub-group of the Task Group on Thermal Hydraulic System Behaviour as requested by the OECD/NEA Committee on Safety of Nuclear Installations (SCNI) Principal Working Group No. 2 on Coolant System Behaviour. The construction of such a Matrix is an attempt to collect together in a systematic way the best sets of openly available test data for code validation, assessment and improvement and also for quantitative code assessment with respect to quantification of uncertainties to the modeling of individual phenomena by the codes. The methodology, that has been developed during the process of establishing CSNI-SET validation matrix, was an important outcome of the work on SET matrix. In addition, all the choices which have been made from the 187 identified facilities covering the 67 phenomena will be investigated together with some discussions on the data base.

29743 (NUREG/CP–0142-Vol.3, pp. 2325-2348) **RELAP5 analyses of two hypothetical flow reversal events for the advanced neutron source reactor.** Chen, N.C.J. (Oak Ridge National Lab., TN (United States)); Wendel, M.W.; Yoder, G.L. Jr. Nuclear Regulatory Commission, Washington, DC (United States). Div. of Systems Technology; American Nuclear Society, La Grange Park, IL (United States); American Inst. of Chemical Engineers, New York, NY (United States); American Society of Mechanical Engineers, New York, NY (United States); Canadian Nuclear Society, Toronto, ON (Canada); European Nuclear Society (ENS), Bern (Switzerland); Atomic Energy Society of Japan, Tokyo (Japan); Japan Society of Multiphase Flow, Kyoto (Japan). Sep 1995. (CONF-950904–Vol.3: 7. international meeting on nuclear reactor thermal hydraulics, Saratoga, NY (United States), 10-15 Sep 1995). In *Proceedings of the 7th International Meeting on Nuclear Reactor Thermal-Hydraulics NURETH-7, Volume 3, Sessions 12-16.* 1001p. Source: OSTI; NTIS; INIS; GPO.

This paper presents RELAP5 results of two hypothetical, low flow transients analyzed as part of the Advanced Neutron Source Reactor safety program. The reactor design features four independent coolant loops (three active and one in standby), each containing a main curculation pump (with battery powered pony motor), heat exchanger, an accumulator, and a check valve. The first transient assumes one of these pumps fails, and additionally, that the check valve in that loop remains stuck in the open position. This accident is considered extremely unlikely. Flow reverses in this loop, reducing the core flow because much of the coolant is diverted from the intact loops back through the failed loop. The second transient examines a 102-mm-diam instantaneous pipe break near the core inlet (the worst break location). A break is assumed to occur 90 s after a total loss-of-offsite power. Core flow reversal occurs because accumulator injection overpowers the diminishing pump flow. Safety margins are evaluated against four thermal limits: $T_{wall}=T_{sat}$, incipient boiling, onset of significant void, and critical heat flux. For the first transient, the results show that these limits are not exceeded (at a 95% non-exceedance probability level) if the pony motor battery lasts 30 minutes (the present design value). For the second transient, the results show that the closest approach of the fuel surface temperature to the local saturation temperature during core flow reversal is about 39°C. Therefore the fuel remains cool during this transient. Although this work is done specifically for the ANSR geometry and operating conditions, the general conclusions may be applicable to other highly subcooled reactor systems.

29744 (NUREG/CP–0142-Vol.3, pp. 2349-2358) **Melcor benchmarking against integral severe fuel damage tests.** Madni, I.K. (Brookhaven National Lab., Upton, NY (United States)). Nuclear Regulatory Commission, Washington, DC (United States). Div. of Systems Technology; American Nuclear Society, La Grange Park, IL (United States); American Inst. of Chemical Engineers, New York, NY (United States); American Society of Mechanical Engineers, New York, NY (United States); Canadian Nuclear Society, Toronto, ON (Canada); European Nuclear Society (ENS), Bern (Switzerland); Atomic Energy Society of Japan, Tokyo (Japan); Japan Society of Multiphase Flow, Kyoto (Japan). Sep 1995. (CONF-950904–Vol.3: 7. international meeting on nuclear reactor thermal hydraulics, Saratoga, NY (United States), 10-15 Sep 1995). In *Proceedings of the 7th International Meeting on Nuclear Reactor Thermal-Hydraulics NURETH-7, Volume 3, Sessions 12-16.* 1001p. Source: OSTI; NTIS; INIS; GPO.

MELCOR is a fully integrated computer code that models all phases of the progression of severe accidents in light water reactor nuclear power plants, and is being developed for the U.S. Nuclear Regulatory Commission (NRC) by Sandia National Laboratories (SNL). Brookhaven National Laboratory (BNL) has a program with the NRC to provide independent assessment of MELCOR, and a very important part of this program is to benchmark MELCOR against experimental data from integral severe fuel damage tests and predictions of that data from more mechanistic codes such as SCDAP or SCDAP/RELAP5. Benchmarking analyses with MELCOR have been carried out at BNL for five integral severe fuel damage tests, namely, PBF SFD 1-1, SFD 14, and NRU FLHT-2, analyses, and their role in identifying areas of modeling strengths and weaknesses in MELCOR.

29745 (NUREG/CP–0142-Vol.3, pp. 2359-2383) **Validation of the THIRMAL-1 melt-water interaction code.** Chu, C.C. (Argonne National Lab., IL (United States)); Sienicki, J.J.; Spencer, B.W. Nuclear Regulatory Commission, Washington, DC (United States). Div. of Systems Technology; American Nuclear Society, La Grange Park, IL (United States); American Inst. of Chemical Engineers, New York, NY (United States); American Society of Mechanical Engineers, New York, NY (United States); Canadian Nuclear Society, Toronto, ON (Canada); European Nuclear Society (ENS), Bern (Switzerland); Atomic Energy Society of Japan, Tokyo (Japan); Japan Society of Multiphase Flow, Kyoto (Japan). Sep 1995. (CONF-950904–Vol.3: 7. international meeting on nuclear reactor thermal hydraulics, Saratoga, NY (United States), 10-15 Sep 1995). In *Proceedings of the 7th International Meeting on Nuclear*

Reactor Thermal-Hydraulics NURETH-7, Volume 3, Sessions 12-16. 1001p. Source: OSTI; NTIS; INIS; GPO.

The THIRMAL-1 computer code has been used to calculate nonexplosive LWR melt-water interactions both in-vessel and ex-vessel. To support the application of the code and enhance its acceptability, THIRMAL-1 has been compared with available data from two of the ongoing FARO experiments at Ispra and two of the Corium Coolant Mixing (CCM) experiments performed at Argonne. THIRMAL-1 calculations for the FARO Scoping Test and Quenching Test 2 as well as the CCM-5 and -6 experiments were found to be in excellent agreement with the experiment results. This lends confidence to the modeling that has been incorporated in the code describing melt stream breakup due to the growth of both Kelvin-Helmholtz and large wave instabilities, the sizes of droplets formed, multiphase flow and heat transfer in the mixing zone surrounding and below the melt metallic phase. As part of the analysis of the FARO tests, a mechanistic model was developed to calculate the prefragmentation as it may have occurred when melt relocated from the release vessel to the water surface and the model was compared with the relevant data from FARO.

29746 (NUREG/CP–0142-Vol.3, pp. 2384-2393) **Experimental assessment of computer codes used for safety analysis of integral reactors.** Falkov, A.A. (OKB Mechanical Engineering, Nizhny Novgorod (Russian Federation)); Kuul, V.S.; Samoilov, O.B. Nuclear Regulatory Commission, Washington, DC (United States). Div. of Systems Technology; American Nuclear Society, La Grange Park, IL (United States); American Inst. of Chemical Engineers, New York, NY (United States); American Society of Mechanical Engineers, New York, NY (United States); Canadian Nuclear Society, Toronto, ON (Canada); European Nuclear Society (ENS), Bern (Switzerland); Atomic Energy Society of Japan, Tokyo (Japan); Japan Society of Multiphase Flow, Kyoto (Japan). Sep 1995. (CONF-950904–Vol.3: 7. international meeting on nuclear reactor thermal hydraulics, Saratoga, NY (United States), 10-15 Sep 1995). In *Proceedings of the 7th International Meeting on Nuclear Reactor Thermal-Hydraulics NURETH-7, Volume 3, Sessions 12-16.* 1001p. Source: OSTI; NTIS; INIS; GPO.

Peculiarities of integral reactor thermohydraulics in accidents are associated with presence of noncondensable gas in built-in pressurizer, absence of pumped ECCS, use of guard vessel for LOCAs localisation and passive RHRS through in-reactor HX's. These features defined the main trends in experimental investigations and verification efforts for computer codes applied. The paper reviews briefly the performed experimental investigation of thermohydraulics of AST-500, VPBER600-type integral reactors. The characteristic of UROVEN/MB-3 code for LOCAs analysis in integral reactors and results of its verification are given. The assessment of RELAP5/mod3 applicability for accident analysis in integral reactor is presented.

29747 (NUREG/CP–0142-Vol.3, pp. 2410-2427) **RELAP5 model to simulate the thermal-hydraulic effects of grid spacers and cladding rupture during reflood.** Nithianandan, C.K. (B&W Nuclear Technologies, Lynchburg, VA (United States)); Klingenfus, J.A.; Reilly, S.S. Nuclear Regulatory Commission, Washington, DC (United States). Div. of Systems Technology; American Nuclear Society, La Grange Park, IL (United States); American Inst. of Chemical Engineers, New York, NY (United States); American Society of Mechanical Engineers, New York, NY (United States); Canadian Nuclear Society, Toronto, ON (Canada); European Nuclear Society (ENS), Bern (Switzerland); Atomic Energy Society of Japan, Tokyo (Japan); Japan Society of Multiphase Flow, Kyoto (Japan). Sep 1995. (CONF-950904–Vol.3: 7. international meeting on nuclear reactor thermal hydraulics, Saratoga, NY (United States), 10-15 Sep 1995). In *Proceedings of the 7th International Meeting on Nuclear Reactor Thermal-Hydraulics NURETH-7, Volume 3, Sessions 12-16.* 1001p. Source: OSTI; NTIS; INIS; GPO.

Droplet breakup at spacer grids and a cladding swelled and ruptured locations plays an important role in the cooling of nuclear fuel rods during the reflooding period of a loss-of-coolant accident (LOCA) in a pressurized water reactor (PWR). During the reflood phase, a spacer grid affects the thermal-hydraulic system behavior through increased turbulence, droplet breakup due to impact on grid straps, grid rewetting, and liquid holdup due to grid form losses. Recently, models to simulate spacer grid effects and blockage and rupture effects on system thermal hydraulics were added to the B&W Nuclear Technologies (BWNT) version of the RELAP5/MOD2 computer code. Several FLECHT-SEASET forced reflood tests, CCTF Tests C1-19 and C2-6, SCTF Test S3-15, and G2 Test 561 were simulated using RELAP5/MOD2-B&W to verify the applicability of the model at the cladding swelled and rupture locations. The results demonstrate the importance of modeling the thermal-hydraulic effects due to grids, and clad swelling and rupture to correctly predict the clad temperature response during the reflood phase of large break LOCA. The RELAP5 models and the test results are described in this paper.

29748 (NUREG/CP–0142-Vol.3, pp. 2428-2437) **Validation of advanced NSSS simulator model for loss-of-coolant accidents.** Kao, S.P. (Nuclear Training Branch, Northeast Utilities, Waterford, CT (United States)); Chang, S.K.; Huang, H.C. Nuclear Regulatory Commission, Washington, DC (United States). Div. of Systems Technology; American Nuclear Society, La Grange Park, IL (United States); American Inst. of Chemical Engineers, New York, NY (United States); American Society of Mechanical Engineers, New York, NY (United States); Canadian Nuclear Society, Toronto, ON (Canada); European Nuclear Society (ENS), Bern (Switzerland); Atomic Energy Society of Japan, Tokyo (Japan); Japan Society of Multiphase Flow, Kyoto (Japan). Sep 1995. (CONF-950904–Vol.3: 7. international meeting on nuclear reactor thermal hydraulics, Saratoga, NY (United States), 10-15 Sep 1995). In *Proceedings of the 7th International Meeting on Nuclear Reactor Thermal-Hydraulics NURETH-7, Volume 3, Sessions 12-16.* 1001p. Source: OSTI; NTIS; INIS; GPO.

The replacement of the NSSS (Nuclear Steam Supply System) model on the Millstone 2 full-scope simulator has significantly increased its fidelity to simulate adverse conditions in the RCS. The new simulator NSSS model is a real-time derivative of the Nuclear Plant Analyzer by ABB. The thermal-hydraulic model is a five-equation, non-homogeneous model for water, steam, and noncondensible gases. The neutronic model is a three-dimensional nodal diffusion model. In order to certify the new NSSS model for operator training, an extensive validation effort has been performed by benchmarking the model performance against RELAP5/MOD2. This paper presents the validation results for the cases of small- and large-break loss-of-coolant accidents (LOCA). Detailed comparisons in the phenomena of reflux-condensation, phase separation, and two-phase natural circulation are discussed.

29749 (NUREG/CP–0142-Vol.3, pp. 2438-2451) **Severe accident simulation at Olkiuoto.** Tirkkonen, H. (Teollisuuden Voima Oy (TVO), Olkiluoto (Finland)); Saarenpaeae, T.; Cliff Po, L.C. Nuclear Regulatory Commission, Washington, DC (United States). Div. of Systems Technology; American Nuclear Society, La Grange Park, IL (United States); American Inst. of Chemical Engineers, New York, NY (United States); American Society of Mechanical Engineers, New York, NY (United States); Canadian Nuclear Society, Toronto, ON (Canada); European Nuclear Society (ENS), Bern (Switzerland); Atomic Energy Society of Japan, Tokyo (Japan); Japan Society of Multiphase Flow, Kyoto (Japan). Sep 1995. (CONF-950904–Vol.3: 7. international meeting on nuclear reactor thermal hydraulics, Saratoga, NY (United States), 10-15 Sep 1995). In *Proceedings of the 7th International Meeting on Nuclear Reactor Thermal-Hydraulics NURETH-7, Volume 3, Sessions 12-16.* 1001p. Source: OSTI; NTIS; INIS; GPO.

A personal computer-based simulator was developed for the Olkiluoto nuclear plant in Finland for training in severe accident management. The generic software PCTRAN was expanded to model the plant-specific features of the ABB Atom designed BWR including its containment over-pressure protection and filtered vent systems. Scenarios including core heat-up, hydrogen generation, core melt and vessel penetration were developed in this work. Radiation leakage paths and dose rate distribution are presented graphically for operator use in diagnosis and mitigation of accidents. Operating on an graphically for operator use in diagnosis and mitigation of accidents. Operating on an 486 DX2-66, PCTRAN-TVO achieves a speed about 15 times faster than real-time. A convenient and user-friendly graphic interface allows full

interactive control. In this paper a review of the component models and verification runs are presented.

29750 (NUREG/CP–0142-Vol.3, pp. 21692184) **The analysis of SCS return momentum effects on the RCS water level during mid-loop operations.** swang Seo, J. (Seoul National Univ. (Korea, Republic of)); Young Yang, J.; Tack Hwang, S. Nuclear Regulatory Commission, Washington, DC (United States). Div. of Systems Technology; American Nuclear Society, La Grange Park, IL (United States); American Inst. of Chemical Engineers, New York, NY (United States); American Society of Mechanical Engineers, New York, NY (United States); Canadian Nuclear Society, Toronto, ON (Canada); European Nuclear Society (ENS), Bern (Switzerland); Atomic Energy Society of Japan, Tokyo (Japan); Japan Society of Multiphase Flow, Kyoto (Japan). Sep 1995. (CONF-950904–Vol.3: 7. international meeting on nuclear reactor thermal hydraulics, Saratoga, NY (United States), 10-15 Sep 1995). In *Proceedings of the 7th International Meeting on Nuclear Reactor Thermal-Hydraulics NURETH-7, Volume 3, Sessions 12-16.* 1001p. Source: OSTI; NTIS; INIS; GPO.

An accurate prediction of Reactor Coolant System (RCS) water levels is of importance in the determination of allowable operating range to ensure the safety during the mid-loop operations. However, complex hydraulic phenomena induced by Shutdown Cooling System (SCS) return momentum cause different water levels from those in the loop where the water level indicators are located. This was apparantly observed at the pre-core cold hydro test of the Younggwang Nuclear Unit 3 (YGN 3) in Korea. In this study, in order to analytically understand the effect of the SCS return momentum on the RCS water level and its general trend, a model using one-dimensional momentum equation, hydraulic jump, Bernoulli equation, flow resistance coefficient, and total water volume conservation has been developed to predict the RCS water levels at various RCS locations during the mid-loop conditions and the simulation results were compared with the test data. The analysis shows that the hydraulic jump in the operating cold legs in conjunction with the momentum loss throughout the RCS is the main cause creating the water level differences at various RCS locations. The prediction results provide good explanations for the test data and show the significant effect of the SCS return momentum on the RCS water levels.

29751 (NUREG/CP–0142-Vol.4, pp. 2539-2557) **New model for burnout prediction in channels of various cross-section.** Bobkov, V.P. (Institute of Physics and Power Engineering, Kaluga (Russian Federation)); Kozina, N.V.; Vinogrado, V.N.; Zyatnina, O.A. Nuclear Regulatory Commission, Washington, DC (United States). Div. of Systems Technology; American Nuclear Society, La Grange Park, IL (United States); American Inst. of Chemical Engineers, New York, NY (United States); American Society of Mechanical Engineers, New York, NY (United States); Canadian Nuclear Society, Toronto, ON (Canada); European Nuclear Society (ENS), Bern (Switzerland); Atomic Energy Society of Japan, Tokyo (Japan); Japan Society of Multiphase Flow, Kyoto (Japan). Sep 1995. (CONF-950904–Vol.4: 7. international meeting on nuclear reactor thermal hydraulics, Saratoga, NY (United States), 10-15 Sep 1995). In *Proceedings of the 7th International Meeting on Nuclear Reactor Thermal-Hydraulics NURETH-7. Sessions 17-24.* 825p. Source: OSTI; NTIS; INIS; GPO.

The model developed to predict a critical heat flux (CHF) in various channels is presented together with the results of data analysis. A model is the realization of relative method of CHF describing based on the data for round tube and on the system of correction factors. The results of data description presented here are for rectangular and triangular channels, annuli and rod bundles.

29752 (NUREG/CP–0142-Vol.4, pp. 2558-2582) **On the look-up tables for the critical heat flux in tubes (history and problems).** Kirillov, P.L. (Institute of Physics and Power Engineering, Kaluga (Russian Federation)); Smogalev, I.P. Nuclear Regulatory Commission, Washington, DC (United States). Div. of Systems Technology; American Nuclear Society, La Grange Park, IL (United States); American Inst. of Chemical Engineers, New York, NY (United States); American Society of Mechanical Engineers, New York, NY (United States); Canadian Nuclear Society, Toronto, ON (Canada); European Nuclear Society (ENS), Bern (Switzerland); Atomic Energy Society of Japan, Tokyo (Japan); Japan Society of Multiphase Flow, Kyoto (Japan). Sep 1995. Contract 6356.5. (CONF-950904–Vol.4: 7. international meeting on nuclear reactor thermal hydraulics, Saratoga, NY (United States), 10-15 Sep 1995). In *Proceedings of the 7th International Meeting on Nuclear Reactor Thermal-Hydraulics NURETH-7. Sessions 17-24.* 825p. Source: OSTI; NTIS; INIS; GPO.

The complication of critical heat flux (CHF) problem for boiling in channels is caused by the large number of variable factors and the variety of two-phase flows. The existence of several hundreds of correlations for the prediction of CHF demonstrates the unsatisfactory state of this problem. The phenomenological CHF models can provide only the qualitative predictions of CHF primarily in annular-dispersed flow. The CHF look-up tables covered the results of numerous experiments received more recognition in the last 15 years. These tables are based on the statistical averaging of CHF values for each range of pressure, mass flux and quality. The CHF values for regions, where no experimental data is available, are obtained by extrapolation. The correction of these tables to account for the diameter effect is a complicated problem. There are ranges of conditions where the simple correlations cannot produce the reliable results. Therefore, diameter effect on CHF needs additional study. The modification of look-up table data for CHF in tubes to predict CHF in rod bundles must include a method which to take into account the nonuniformity of quality in a rod bundle cross section.

29753 (NUREG/CP–0142-Vol.4, pp. 2654-2668) **A study of the effect of space-dependent neutronics on stochastically-induced bifurcations in BWR dynamics.** Analytis, G.T. (Paul Scherrer Institute (PSI), Villigen (Switzerland)). Nuclear Regulatory Commission, Washington, DC (United States). Div. of Systems Technology; American Nuclear Society, La Grange Park, IL (United States); American Inst. of Chemical Engineers, New York, NY (United States); American Society of Mechanical Engineers, New York, NY (United States); Canadian Nuclear Society, Toronto, ON (Canada); European Nuclear Society (ENS), Bern (Switzerland); Atomic Energy Society of Japan, Tokyo (Japan); Japan Society of Multiphase Flow, Kyoto (Japan). Sep 1995. (CONF-950904–Vol.4: 7. international meeting on nuclear reactor thermal hydraulics, Saratoga, NY (United States), 10-15 Sep 1995). In *Proceedings of the 7th International Meeting on Nuclear Reactor Thermal-Hydraulics NURETH-7. Sessions 17-24.* 825p. Source: OSTI; NTIS; INIS; GPO.

A non-linear one-group space-dependent neutronic model for a finite one-dimensional core is coupled with a simple BWR feed-back model. In agreement with results obtained by the authors who originally developed the point-kinetics version of this model, we shall show numerically that stochastic reactivity excitations may result in limit-cycles and eventually in a chaotic behaviour, depending on the magnitude of the feed-back coefficient K. In the framework of this simple space-dependent model, the effect of the non-linearities on the different spatial harmonics is studied and the importance of the space-dependent effects is exemplified and assessed in terms of the importance of the higher harmonics. It is shown that under certain conditions, when the limit-cycle-type develop, the neutron spectra may exhibit strong space-dependent effects.

29754 (NUREG/CP–0142-Vol.4, pp. 2669-2676) **Analysis of the return to power scenario following a LBLOCA in a PWR.** Macian, R. (Pennsylvania State Univ., University Park, PA (United States)); Tyler, T.N.; Mahaffy, J.H. Nuclear Regulatory Commission, Washington, DC (United States). Div. of Systems Technology; American Nuclear Society, La Grange Park, IL (United States); American Inst. of Chemical Engineers, New York, NY (United States); American Society of Mechanical Engineers, New York, NY (United States); Canadian Nuclear Society, Toronto, ON (Canada); European Nuclear Society (ENS), Bern (Switzerland); Atomic Energy Society of Japan, Tokyo (Japan); Japan Society of Multiphase Flow, Kyoto (Japan). Sep 1995. (CONF-950904–Vol.4: 7. international meeting on nuclear reactor thermal hydraulics, Saratoga, NY (United States), 10-15 Sep 1995). In *Proceedings of the 7th International Meeting on Nuclear Reactor Thermal-Hydraulics NURETH-7. Sessions 17-24.* 825p. Source: OSTI; NTIS; INIS; GPO.

The risk of reactivity accidents has been considered an important safety issue since the beginning of the nuclear power industry. In particular, several events leading to such scenarios for PWR's have been recognized and studied to assess the potential risk of fuel damage. The present paper analyzes one such event: the possible return to power during the reflooding phase following a LBLOCA. TRAC-PF1/MOD2 coupled with a three-dimensional neutronic model of the core based on the Nodal Expansion Method (NEM) was used to perform the analysis. The system computer model contains a detailed representation of a complete typical 4-loop PWR. Thus, the simulation can follow complex system interactions during reflooding, which may influence the neutronics feedback in the core. Analyses were made with core models bases on cross sections generated by LEOPARD. A standard and a potentially more limiting case, with increased pressurizer and accumulator inventories, were run. In both simulations, the reactor reaches a stable state after the reflooding is completed. The lower core region, filled with cold water, generates enough power to boil part of the incoming liquid, thus preventing the core average liquid fraction from reaching a value high enough to cause a return to power. At the same time, the mass flow rate through the core is adequate to maintain the rod temperature well below the fuel damage limit.

29755 (NUREG/CP–0142-Vol.4, pp. 2704-2720) **Coupled calculation of the radiological release and the thermal-hydraulic behavior of a 3-loop PWR after a SGTR by means of the code RELAP5.** Van Hove, W. (Belgatom, Brussels (Belgium)); Van Laeken, K.; Bartsoen, L. Nuclear Regulatory Commission, Washington, DC (United States). Div. of Systems Technology; American Nuclear Society, La Grange Park, IL (United States); American Inst. of Chemical Engineers, New York, NY (United States); American Society of Mechanical Engineers, New York, NY (United States); Canadian Nuclear Society, Toronto, ON (Canada); European Nuclear Society (ENS), Bern (Switzerland); Atomic Energy Society of Japan, Tokyo (Japan); Japan Society of Multiphase Flow, Kyoto (Japan). Sep 1995. (CONF-950904–Vol.4: 7. international meeting on nuclear reactor thermal hydraulics, Saratoga, NY (United States), 10-15 Sep 1995). In *Proceedings of the 7th International Meeting on Nuclear Reactor Thermal-Hydraulics NURETH-7. Sessions 17-24.* 825p. Source: OSTI; NTIS; INIS; GPO.

To enable a more realistic and accurate calculation of the radiological consequences of a SGTR, a fission product transport model was developed. As the radiological releases strongly depend on the thermal-hydraulic transient, the model was included in the RELAP5 input decks of the Belgian NPPs. This enables the coupled calculation of the thermal-hydraulic transient and the radiological release. The fission product transport model tracks the concentration of the fission products in the primary circuit, in each of the SGs as well as in the condenser. This leads to a system of 6 coupled, first order ordinary differential equations with time dependent coefficients. Flashing, scrubbing, atomisation and dry out of the break flow are accounted for. Coupling with the thermal-hydraulic calculation and correct modelling of the break position enables an accurate calculation of the mixture level above the break. Pre- and post-accident spiking in the primary circuit are introduced. The transport times in the FW-system and the SG blowdown system are also taken into account, as is the decontaminating effect of the primary make-up system and of the SG blowdown system. Physical input parameters such as the partition coefficients, half life times and spiking coefficients are explicitly introduced so that the same model can be used for iodine, caesium and noble gases.

29756 (NUREG/CP–0142-Vol.4, pp. 2762-2772) **Void fraction distribution in a heated rod bundle under flow stagnation conditions.** Herrero, V.A. (Centro Atomico Bariloche and Instituto Balseiro, Bariloche (Argentina)); Guido-Lavalle, G.; Clausse, A. Nuclear Regulatory Commission, Washington, DC (United States). Div. of Systems Technology; American Nuclear Society, La Grange Park, IL (United States); American Inst. of Chemical Engineers, New York, NY (United States); American Society of Mechanical Engineers, New York, NY (United States); Canadian Nuclear Society, Toronto, ON (Canada); European Nuclear Society (ENS), Bern (Switzerland); Atomic Energy Society of Japan, Tokyo (Japan); Japan Society of Multiphase Flow, Kyoto (Japan). Sep 1995. (CONF-950904–Vol.4: 7. international meeting on nuclear reactor thermal hydraulics, Saratoga, NY (United States), 10-15 Sep 1995). In *Proceedings of the 7th International Meeting on Nuclear Reactor Thermal-Hydraulics NURETH-7. Sessions 17-24.* 825p. Source: OSTI; NTIS; INIS; GPO.

An experimental study was performed to determine the axial void fraction distribution along a heated rod bundle under flow stagnation conditions. The development of the flow pattern was investigated for different heat flow rates. It was found that in general the void fraction is overestimated by the Zuber & Findlay model while the Chexal-Lellouche correlation produces a better prediction.

29757 (NUREG/CP–0142-Vol.4, pp. 2773-2784) **Numerical determination of lateral loss coefficients for subchannel analysis in nuclear fuel bundles.** Sin Kim (Seoul National Univ., Seoul (Korea, Republic of)); Goon-Cherl Park. Nuclear Regulatory Commission, Washington, DC (United States). Div. of Systems Technology; American Nuclear Society, La Grange Park, IL (United States); American Inst. of Chemical Engineers, New York, NY (United States); American Society of Mechanical Engineers, New York, NY (United States); Canadian Nuclear Society, Toronto, ON (Canada); European Nuclear Society (ENS), Bern (Switzerland); Atomic Energy Society of Japan, Tokyo (Japan); Japan Society of Multiphase Flow, Kyoto (Japan). Sep 1995. (CONF-950904–Vol.4: 7. international meeting on nuclear reactor thermal hydraulics, Saratoga, NY (United States), 10-15 Sep 1995). In *Proceedings of the 7th International Meeting on Nuclear Reactor Thermal-Hydraulics NURETH-7. Sessions 17-24.* 825p. Source: OSTI; NTIS; INIS; GPO.

An accurate prediction of cross-flow based on detailed knowledge of the velocity field in subchannels of a nuclear fuel assembly is of importance in nuclear fuel performance analysis. In this study, the low-Reynolds number κ-ϵ turbulence model has been adopted in two adjacent subchannels with cross-flow. The secondary flow is estimated accurately by the anisotropic algebraic Reynolds stress model. This model was numerically calculated by the finite element method and has been verified successfully through comparison with existing experimental data. Finally, with the numerical analysis of the velocity field in such subchannel domain, an analytical correlation of the lateral loss coefficient is obtained to predict the cross-flow rate in subchannel analysis codes. The correlation is expressed as a function of the ratio of the lateral flow velocity to the donor subchannel axial velocity, recipient channel Reynolds number and pitch-to-diameter.

29758 (NUREG/CP–0142-Vol.4, pp. 2806-2814) **Analysis of steam generator loss-of-feedwater experiments with APROS and RELAP5/MOD3.1 computer codes.** Virtanen, E. (Lappeenranta Univ. of Technology, Lappeenranta (Finland)); Haapalehto, T.; Kouhia, J. Nuclear Regulatory Commission, Washington, DC (United States). Div. of Systems Technology; American Nuclear Society, La Grange Park, IL (United States); American Inst. of Chemical Engineers, New York, NY (United States); American Society of Mechanical Engineers, New York, NY (United States); Canadian Nuclear Society, Toronto, ON (Canada); European Nuclear Society (ENS), Bern (Switzerland); Atomic Energy Society of Japan, Tokyo (Japan); Japan Society of Multiphase Flow, Kyoto (Japan). Sep 1995. (CONF-950904–Vol.4: 7. international meeting on nuclear reactor thermal hydraulics, Saratoga, NY (United States), 10-15 Sep 1995). In *Proceedings of the 7th International Meeting on Nuclear Reactor Thermal-Hydraulics NURETH-7. Sessions 17-24.* 825p. Source: OSTI; NTIS; INIS; GPO.

Three experiments were conducted to study the behavior of the new horizontal steam generator construction of the PACTEL test facility. In the experiments the secondary side coolant level was reduced stepwise. The experiments were calculated with two computer codes RELAP5/MOD3.1 and APROS version 2.11. A similar nodalization scheme was used for both codes to that the results may be compared. Only the steam generator was modelled and the rest of the facility was given as a boundary condition. The results show that both codes calculate well the behaviour of the primary side of the steam generator. On the secondary side both codes calculate lower steam temperatures in the upper part of the heat exchange tube bundle than was measured in the experiments.

29759 (NUREG/CP–0142-Vol.4, pp. 2834-2840) **ISP33 standard problem on the PACTEL facility.** Purhonen, H. (VTT

Energy, Lappeenranta (Finland)); Kouhia, J.; Kalli, H. Nuclear Regulatory Commission, Washington, DC (United States). Div. of Systems Technology; American Nuclear Society, La Grange Park, IL (United States); American Inst. of Chemical Engineers, New York, NY (United States); American Society of Mechanical Engineers, New York, NY (United States); Canadian Nuclear Society, Toronto, ON (Canada); European Nuclear Society (ENS), Bern (Switzerland); Atomic Energy Society of Japan, Tokyo (Japan); Japan Society of Multiphase Flow, Kyoto (Japan). Sep 1995. (CONF-950904–Vol.4: 7. international meeting on nuclear reactor thermal hydraulics, Saratoga, NY (United States), 10-15 Sep 1995). In *Proceedings of the 7th International Meeting on Nuclear Reactor Thermal-Hydraulics NURETH-7. Sessions 17-24.* 825p. Source: OSTI; NTIS; INIS; GPO.

ISP33 is the first OECD/NEA/CSNI standard problem related to VVER type of pressurized water reactors. The reference reactor of the PACTEL test facility, which was used to carry out the ISP33 experiment, is the VVER-440 reactor, two of which are located near the Finnish city of Loviisa. The objective of the ISP33 test was to study the natural circulation behaviour of VVER-440 reactors at different coolant inventories. Natural circulation was considered as a suitable phenomenon to focus on by the first VVER related ISP due to its importance in most accidents and transients. The behaviour of the natural circulation was expected to be different compared to Western type of PWRs as a result of the effect of horizontal steam generators and the hot leg loop seals. This ISP was conducted as a blind problem. The experiment was started at full coolant inventory. Single-phase natural circulation transported the energy from the core to the steam generators. The inventory was then reduced stepwise at about 900 s intervals draining 60 kg each time from the bottom of the downcomer. the core power was about 3.7% of the nominal value. The test was terminated after the cladding temperatures began to rise. ATHLET, CATHARE, RELAP5 (MODs 3, 2.5 and 2), RELAP4/MOD6, DINAMIKA and TECH-M4 codes were used in 21 pre- and 20 posttest calculations submitted for the ISP33.

29760 (NUREG/CP–0142-Vol.4, pp. 2841-2855) **SPES-2, an experimental program to support the AP600 development.** Tarantini, M. (ENEA, Nuclear Fission Branch, Bolonga (Italy)); Medich, C. Nuclear Regulatory Commission, Washington, DC (United States). Div. of Systems Technology; American Nuclear Society, La Grange Park, IL (United States); American Inst. of Chemical Engineers, New York, NY (United States); American Society of Mechanical Engineers, New York, NY (United States); Canadian Nuclear Society, Toronto, ON (Canada); European Nuclear Society (ENS), Bern (Switzerland); Atomic Energy Society of Japan, Tokyo (Japan); Japan Society of Multiphase Flow, Kyoto (Japan). Sep 1995. (CONF-950904–Vol.4: 7. international meeting on nuclear reactor thermal hydraulics, Saratoga, NY (United States), 10-15 Sep 1995). In *Proceedings of the 7th International Meeting on Nuclear Reactor Thermal-Hydraulics NURETH-7. Sessions 17-24.* 825p. Source: OSTI; NTIS; INIS; GPO.

In support of the development of the AP600 reactor, ENEA, ENEL, ANSALDO and Westinghouse have signed a research agreement. In the framework of this agreement a complex Full Height Full Pressure (FHFP) integral system testing program has been planned on SPES-2 facility. The main purpose of this paper is to point out the status of the test program; describe the hot peroperational test performed and the complete test matrix, giving all the necessary references on the work already published. Two identical Small Break LOCA transients, performed with Pressurizer to Core Make-up Tank (PRZ-CMT) balance line (Test S00203) and without PRZ-CMT balance line (Test S00303) are then compared, to show how the SPES-2 facility can contribute in confirming the new AP600 reactor design choices and can give useful indications to designers. Although the detailed analysis of test data has not been completed, some consideration on the analytical tools utilized and on the SPES-2 capability to simulate the reference plant is then drawn.

29761 (NUREG/CP–0142-Vol.4, pp. 2856-2868) **PWR-related integral safety experiments in the PKL 111 test facility SBLOCA under beyond-design-basis accident conditions.** Weber, P. (Siemens AG Power Generation Group (KWU), Erlangen (France)); Umminger, K.J.; Schoen, B. Nuclear Regulatory Commission, Washington, DC (United States). Div. of Systems Technology; American Nuclear Society, La Grange Park, IL (United States); American Inst. of Chemical Engineers, New York, NY (United States); American Society of Mechanical Engineers, New York, NY (United States); Canadian Nuclear Society, Toronto, ON (Canada); European Nuclear Society (ENS), Bern (Switzerland); Atomic Energy Society of Japan, Tokyo (Japan); Japan Society of Multiphase Flow, Kyoto (Japan). Sep 1995. (CONF-950904–Vol.4: 7. international meeting on nuclear reactor thermal hydraulics, Saratoga, NY (United States), 10-15 Sep 1995). In *Proceedings of the 7th International Meeting on Nuclear Reactor Thermal-Hydraulics NURETH-7. Sessions 17-24.* 825p. Source: OSTI; NTIS; INIS; GPO.

The thermal hydraulic behavior of a PWR during beyond-design-basis accident scenarios is of vital interest for the verification and optimization of accident management procedures. Within the scope of the German reactor safety research program experiments were performed in the volumetrically scaled PKL 111 test facility by Siemens/KWU. This highly instrumented test rig simulates a KWU-design PWR (1300 MWe). In particular, the latest tests performed related to a SBLOCA with additional system failures, e.g. nitrogen entering the primary system. In the case of a SBLOCA, it is the goal of the operator to put the plant in a condition where the decay heat can be removed first using the low pressure emergency core cooling system and then the residual heat removal system. The experimental investigation presented assumed the following beyond-design-basis accident conditions: 0.5% break in a cold leg, 2 of 4 steam generators (SGs) isolated on the secondary side (feedwater- and steam line-valves closed), filled with steam on the primary side, cooldown of the primary system using the remaining two steam generators, high pressure injection system only in the two loops with intact steam generators, if possible no operator actions to reach the conditions for residual heat removal system activation. Furthermore, it was postulated that 2 of the 4 hot leg accumulators had a reduced initial water inventory (increased nitrogen inventory), allowing nitrogen to enter the primary system at a pressure of 15 bar and nearly preventing the heat transfer in the SGs ("passivating" U-tubes). Due to this the heat transfer regime in the intact steam generators changed remarkably. The primary system showed self-regulating system effects and heat transfer improved again (reflux-condenser mode in the U-tube inlet region).

29762 (NUREG/CP–0142-Vol.4, pp. 2869-2883) **SPES-2, AP600 intergral system test S01007 2 inch CL to core make-up tank pressure balance line break.** Bacchiani, M. (SIET S.p.A. Piacenza (Italy)); Medich, C.; Rigamonti, M. Nuclear Regulatory Commission, Washington, DC (United States). Div. of Systems Technology; American Nuclear Society, La Grange Park, IL (United States); American Inst. of Chemical Engineers, New York, NY (United States); American Society of Mechanical Engineers, New York, NY (United States); Canadian Nuclear Society, Toronto, ON (Canada); European Nuclear Society (ENS), Bern (Switzerland); Atomic Energy Society of Japan, Tokyo (Japan); Japan Society of Multiphase Flow, Kyoto (Japan). Sep 1995. (CONF-950904–Vol.4: 7. international meeting on nuclear reactor thermal hydraulics, Saratoga, NY (United States), 10-15 Sep 1995). In *Proceedings of the 7th International Meeting on Nuclear Reactor Thermal-Hydraulics NURETH-7. Sessions 17-24.* 825p. Source: OSTI; NTIS; INIS; GPO.

The SPES-2 is a full height, full pressure experimental test facility reproducing the Westinghouse AP600 reactor with a scaling factor of 1/395. The experimental plant, designed and operated by SIET in Piacenza, consists of a full simulation of the AP600 primary core cooling system including all the passive and active safety systems. In 1992, Westinghouse, in cooperation with ENEL (Ente Nazionale per l' Energia Elettrica), ENEA (Enter per le numove Technlogie, l' Energia e l' Ambient), Siet (Societa Informazioni Esperienze Termoidraulich) and ANSALDO developed an experimental program to test the integrated behaviour of the AP600 passive safety systems. The SPES-2 test matrix, concluded in November 1994, has examined the AP600 passive safety system response for a range of small break LOCAs at different locations on the primary system and on the passive system lines; single steam generator tube ruptures with passive and active safety systems and a main steam

line break transient to demonstrate the boration capability of passive safety systems for rapid cooldown. Each of the tests has provided detailed experimental results for verification of the capability of the analysis methods to predict the integrated passive safety system behaviour. Cold and hot shakedown tests have been performed on the facility to check the characteristics of the plant before starting the experimental campaign. The paper first presents a description of the SPES-2 test facility then the main results of S01007 test "2" Cold Leg (CL) to Core Make-up Tank (CMT) pressure balance line break" are reported and compared with predictions performed using RELAP5/mod3/80 obtained by ANSALDO through agreement with U.S.N.R.C. (U.S. Nuclear Regulatory Commission). The SPES-2 nodalization and all the calculations here presented were performed by ANSALDO and sponsored by ENEL as a part of pre-test predictions for SPES-2.

29763 (NUREG/CP–0142-Vol.4, pp. 2895-2903) **Physical modelling of a rapid boron dilution transient.** Anderson, N.G. (Vattenfall Utveckling AB, Aelvkarleby (Sweden)); Hemstroem, B.; Karlsson, R.; Jacobson, S. Nuclear Regulatory Commission, Washington, DC (United States). Div. of Systems Technology; American Nuclear Society, La Grange Park, IL (United States); American Inst. of Chemical Engineers, New York, NY (United States); American Society of Mechanical Engineers, New York, NY (United States); Canadian Nuclear Society, Toronto, ON (Canada); European Nuclear Society (ENS), Bern (Switzerland); Atomic Energy Society of Japan, Tokyo (Japan); Japan Society of Multiphase Flow, Kyoto (Japan). Sep 1995. (CONF-950904–Vol.4: 7. international meeting on nuclear reactor thermal hydraulics, Saratoga, NY (United States), 10-15 Sep 1995). In *Proceedings of the 7th International Meeting on Nuclear Reactor Thermal-Hydraulics NURETH-7. Sessions 17-24.* 825p. Source: OSTI; NTIS; INIS; GPO.

The analysis of boron dilution accidents in pressurised water reactors has traditionally assumed that mixing is instantaneous and complete everywhere, eliminating in this way the possibility of concentration inhomogeneities. Situations can nevertheless arise where a volume of coolant with a low boron concentration may eventually enter the core and generate a severe reactivity transient. The work presented in this paper deals with a category of Rapid Boron Dilution Events characterised by a rapid start of a Reactor Coolant Pump (RCP) with a plug of relatively unborated water present in the RCS pipe. Model tests have been made at Vattenfall Utveckling AB in a simplified 1:5 scale model of a Westinghouse PWR. Conductivity measurements are used to determine dimensionless boron concentration. The main purpose of this experimental work is to define an experimental benchmark against which a mathematical model can be tested. The final goal is to be able to numerically predict Boron Dilution Transients. This work has been performed as a part of a Co-operative Agreement with Electricite' de France (EDF).

29764 (NUREG/CP–0142-Vol.4, pp. 2904-2915) **Further evaluation of the CSNI separate effect test activity.** D'Auria, F. (and others); Aksan, S.N.; Glaeser, H. Nuclear Regulatory Commission, Washington, DC (United States). Div. of Systems Technology; American Nuclear Society, La Grange Park, IL (United States); American Inst. of Chemical Engineers, New York, NY (United States); American Society of Mechanical Engineers, New York, NY (United States); Canadian Nuclear Society, Toronto, ON (Canada); European Nuclear Society (ENS), Bern (Switzerland); Atomic Energy Society of Japan, Tokyo (Japan); Japan Society of Multiphase Flow, Kyoto (Japan). Sep 1995. (CONF-950904–Vol.4: 7. international meeting on nuclear reactor thermal hydraulics, Saratoga, NY (United States), 10-15 Sep 1995). In *Proceedings of the 7th International Meeting on Nuclear Reactor Thermal-Hydraulics NURETH-7. Sessions 17-24.* 825p. Source: OSTI; NTIS; INIS; GPO.

An internationally agreed Separate Effect Test (SET) Validation Matrix for the thermalhydraulic system codes has been established by a subgroup of the Task Group on Thermalhydraulic System Behaviour as requested by OECD/NEA Committee on the Safety of Nuclear Installations (CSNI) Principal Working Group No. 2 on Coolant System Behavior. The construction of such matrix constituted an attempt to collect together in a systematic way the best sets of openly available test data to select for code validation. As a final result, 67 phenomena have been identified and characterized, roughly 200 facilities have been considered and more than 1000 experiments have been selected as useful for the validation of the codes. The objective of the present paper is to provide additional evaluation of the obtained data base and to supply an a-posteriori judgement in relation to (a) the data base adequacy, (b) the phenomenon, and (c) the need for additional experiments. This has been provided independently by each of the authors. The main conclusions are that large amount of data are available for certain popular phenomena e.g. heat transfer, but data are severely lacking in more esoteric areas e.g. for characterizing phenomena such as parallel channel instability and boron mixing and transport.

29765 (NUREG/CP–0142-Vol.4, pp. 2957-2976) **Modeling and analysis of thermal-hydraulic response of uranium-aluminum reactor fuel plates under transient heatup conditions.** Navarro-Valenti, S. (Oak Ridge National Lab., TN (United States)); Kim, S.H.; Georgevich, V. Nuclear Regulatory Commission, Washington, DC (United States). Div. of Systems Technology; American Nuclear Society, La Grange Park, IL (United States); American Inst. of Chemical Engineers, New York, NY (United States); American Society of Mechanical Engineers, New York, NY (United States); Canadian Nuclear Society, Toronto, ON (Canada); European Nuclear Society (ENS), Bern (Switzerland); Atomic Energy Society of Japan, Tokyo (Japan); Japan Society of Multiphase Flow, Kyoto (Japan). Sep 1995. (CONF-950904–Vol.4: 7. international meeting on nuclear reactor thermal hydraulics, Saratoga, NY (United States), 10-15 Sep 1995). In *Proceedings of the 7th International Meeting on Nuclear Reactor Thermal-Hydraulics NURETH-7. Sessions 17-24.* 825p. Source: OSTI; NTIS; INIS; GPO.

The purpose of this paper is to describe the analysis performed to predict the thermal behavior of fuel miniplates under rapid transient heatup conditions. The possibility of explosive boiling was considered, and it was concluded that the heating rates are not large enough for explosive boiling to occur. However, transient boiling effects were pronounced. Because of the complexity of transient pool boiling and the unavailability of experimental data for the situations studied, an approximation was made that predicted the data very well within the uncertainties present. If pool boiling from the miniplates had been assumed to be steady during the heating pulse, the experimental data would have been greatly overestimated. This fact demonstrates the importance of considering the transient nature of heat transfer in the analysis of reactivity excursion accidents. An additional contribution of the present work is that it provided data on highly subcooled steady nulceate boiling from the cooling portion of the thermocouple traces.

29766 (NUREG/CP–0142-Vol.4, pp. 2977-2993) **Study on severe accident fuel dispersion behavior in the advanced neutron source reactor at Oak Ridge National Laboratory.** Kim, S.H. (Oak Ridge National Lab., TN (United States)); Taleyarkhan, R.P.; Navarro-Valenti, S. Nuclear Regulatory Commission, Washington, DC (United States). Div. of Systems Technology; American Nuclear Society, La Grange Park, IL (United States); American Inst. of Chemical Engineers, New York, NY (United States); American Society of Mechanical Engineers, New York, NY (United States); Canadian Nuclear Society, Toronto, ON (Canada); European Nuclear Society (ENS), Bern (Switzerland); Atomic Energy Society of Japan, Tokyo (Japan); Japan Society of Multiphase Flow, Kyoto (Japan). Sep 1995. DOE Contract AC05-84OR21400. (CONF-950904–Vol.4: 7. international meeting on nuclear reactor thermal hydraulics, Saratoga, NY (United States), 10-15 Sep 1995). In *Proceedings of the 7th International Meeting on Nuclear Reactor Thermal-Hydraulics NURETH-7. Sessions 17-24.* 825p. Source: OSTI; NTIS; INIS; GPO.

Core flow blockage events have been determined to represent a leading contributor to core damage initiation risk in the Advanced Neutron Source (ANS) reactor. During such an accident, insufficient cooling of the fuel in a few adjacent blocked coolant channels out of several hundred channels, could also result in core heatup and melting under full coolant flow condition in other coolant channels. Coolant inertia forces acting on the melt surface would likely break up the melt into small particles. Under thermal-hydraulic conditions of ANS coolant channel, micro-fine melt particles are

expected. Hat transfer between melt particle and coolant, which affects the particle breakup characteristics, was studied. The study indicates that the thermal effect on melt fragmentation seems to be negligible because the time corresponding to the breakup due to hydrodynamic forces is much shorter than the time for the melt surface to solidify. The study included modeling and analyses to predict transient behavior and transport of debris particles throughout the coolant system. The transient model accounts for the surface forces acting on the particle that results from the pressure variation on the surface, inertia, virtual mass, viscous force due to the relative motion of the particle in the coolant, gravitation, and resistance due to inhomogenous coolant velocity radially across piping due to possible turbulent coolant motions. The results indicate that debris particles would reside longest in heat exchangers because of lower coolant velocity there. Also they are entrained and move together in a cloud.

29767 (NUREG/CP–0142-Vol.4, pp. 2994-3002) **The Phebus FP thermal-hydraulic analysis with Melcor.** Akgane, Kikuo (Nuclear Power Engineering Corporation, Tokyo (Japan)); Kiso, Yoshihiro; Fukahori, Takanori; Yoshino, Mamoru. Nuclear Regulatory Commission, Washington, DC (United States). Div. of Systems Technology; American Nuclear Society, La Grange Park, IL (United States); American Inst. of Chemical Engineers, New York, NY (United States); American Society of Mechanical Engineers, New York, NY (United States); Canadian Nuclear Society, Toronto, ON (Canada); European Nuclear Society (ENS), Bern (Switzerland); Atomic Energy Society of Japan, Tokyo (Japan); Japan Society of Multiphase Flow, Kyoto (Japan). Sep 1995. (CONF-950904–Vol.4: 7. international meeting on nuclear reactor thermal hydraulics, Saratoga, NY (United States), 10-15 Sep 1995). In *Proceedings of the 7th International Meeting on Nuclear Reactor Thermal-Hydraulics NURETH-7. Sessions 17-24.* 825p. Source: OSTI; NTIS; INIS; GPO.

The severe accident analysis code MELCOR, version 1.8.2, has been applied for thermal-hydraulic pre-test analysis of the first test of the Phebus FP program (test FPT-0) to study the best test parameters and the applicability of the code. The Phebus FP program is an in-pile test program which has been planned by the French Commissariate a L'Energie Atomique and the Commission of the European Union. The experiments are being conducted by an international collaboration to study the release and transport of fission products (FPs) under conditions assumed to be the most representative of those that would occur in a severe accident. The Phebus FP test apparatus simulates a test bundle of an in-pile section, the circuit including the steam generator U-tubes and the containment. The FPT-0 test was designed to simulate the heat-up and subsequent fuel bundle degradation after a loss of coolant severe accident, using fresh fuel. Two options for fuel degradation models in MELCOR have been applied to fuel degradation behavior. the first model assumes that fuel debris will be formed immediately after the fuel support fails by cladding relocation due to the candling process. The other is the uncollapsed bare fuel pellets option, in which the fuel pellets remain standing in a columnar shape until the fuel reaches its melting point, even if the cladding has been relocated by candling. The thermal-hydraulic behaviors in the circuit and containment of Phebus FP are discussed herein. Flow velocities in the Phebus FP circuit are high in order to produce turbulent flow in a small diameter test pipe. The MELCOR calculation has shown that the length of the hot leg and steam generator are adequate to attain steam temperatures or 700°C and 150°C in the respective outlets. The containment atmosphere temperature and humidity derived by once through integral system calculation show that objective test conditions would be satisfied in the Phebus FP experiment.

29768 (NUREG/CP–0142-Vol.4, pp. 3028-3051) **Thermal-hydraulics of wave propagation and pressure distribution under hypothetical steam explosion conditions in the ANS reactor.** Taleyarkhan, R.P. (Oak Ridge National Lab., TN (United States)); Georgevich, V.; N-Valenit, S.; Kim, S.H. Nuclear Regulatory Commission, Washington, DC (United States). Div. of Systems Technology; American Nuclear Society, La Grange Park, IL (United States); American Inst. of Chemical Engineers, New York, NY (United States); American Society of Mechanical Engineers, New York, NY (United States); Canadian Nuclear Society, Toronto, ON (Canada); European Nuclear Society (ENS), Bern (Switzerland); Atomic Energy Society of Japan, Tokyo (Japan); Japan Society of Multiphase Flow, Kyoto (Japan). Sep 1995. (CONF-950904–Vol.4: 7. international meeting on nuclear reactor thermal hydraulics, Saratoga, NY (United States), 10-15 Sep 1995). In *Proceedings of the 7th International Meeting on Nuclear Reactor Thermal-Hydraulics NURETH-7. Sessions 17-24.* 825p. Source: OSTI; NTIS; INIS; GPO.

This paper describes salient aspects of the modeling and analysis framework for evaluation of dynamic loads, wave propagation, and pressure distributions (under hypothetical steam explosion conditions) around key structural boundaries of the Advanced Neutron Source (ANS) reactor core region. A staged approach was followed, using simple thermodynamic models for bounding loads and the CTH code for evaluating realistic estimates in a staged multidimensional framework. Effects of nodalization, melt dispersal into coolant during explosion, single versus multidirectional dissipation, energy level of melt, and rate of energy deposition into coolant were studied. The importance of capturing multidimensional effects that simultaneously account for fluid-structural interactions was demonstrated. As opposed to using bounding loads from thermodynamic evaluations, it was revealed that the ANS reactor system will not be vulnerable to vertically generated missiles that threaten containment if realistic estimates of energetics are used (from CTH calculations for thermally generated steam explosions without significant aluminum ignition).

29769 (NUREG/CP–0142-Vol.4, pp. 3052-3072) **Modeling and analysis framework for core damage propagation during flow-blockage-initiated accidents in the advanced neutron source reactor at Oak Ridge National Laboratory.** Kim, S.H. (Oak Ridge National Lab., TN (United States)); Taleyarkhan, R.P.; Navarro-Valenti, S.; Georgevich, V. Nuclear Regulatory Commission, Washington, DC (United States). Div. of Systems Technology; American Nuclear Society, La Grange Park, IL (United States); American Inst. of Chemical Engineers, New York, NY (United States); American Society of Mechanical Engineers, New York, NY (United States); Canadian Nuclear Society, Toronto, ON (Canada); European Nuclear Society (ENS), Bern (Switzerland); Atomic Energy Society of Japan, Tokyo (Japan); Japan Society of Multiphase Flow, Kyoto (Japan). Sep 1995. DOE Contract AC05-84OR21400. (CONF-950904–Vol.4: 7. international meeting on nuclear reactor thermal hydraulics, Saratoga, NY (United States), 10-15 Sep 1995). In *Proceedings of the 7th International Meeting on Nuclear Reactor Thermal-Hydraulics NURETH-7. Sessions 17-24.* 825p. Source: OSTI; NTIS; INIS; GPO.

This paper describes modeling and analysis to evaluate the extent of core damage during flow blockage events in the Advanced Neutron Source (ANS) reactor planned to be built at the Oak Ridge National Laboratory (ORNL). Damage propagation is postulated to occur from thermal conduction between damaged and undamaged plates due to direct thermal contact. Such direct thermal contact may occur because of fuel plate swelling during fission product vapor release or plate buckling. Complex phenomena of damage propagation were modeled using a one-dimensional heat transfer model. A scoping study was conducted to learn what parameters are important for core damage propagation, and to obtain initial estimates of core melt mass for addressing recriticality and steam explosion events. The study included investigating the effect of the plate contact area, the convective heat transfer coefficient, thermal conductivity upon fuel swelling, and the initial temperature of the plate being contacted by the damaged plate. Also, the side support plates were modeled to account for their effects on damage propagation. The results provide useful insights into how various uncertain parameters affect damage propagation.

29770 (NUREG/CP–0142-Vol.4, pp. 3096-3119) **Numerical Boron mixing studies for Lovlisa Nuclear Power Plant.** Gango, P. (IVO International Ltd. (Finland)). Nuclear Regulatory Commission, Washington, DC (United States). Div. of Systems Technology; American Nuclear Society, La Grange Park, IL (United States); American Inst. of Chemical Engineers, New York, NY (United States); American Society of Mechanical Engineers, New York, NY (United States); Canadian Nuclear Society, Toronto, ON (Canada);

European Nuclear Society (ENS), Bern (Switzerland); Atomic Energy Society of Japan, Tokyo (Japan); Japan Society of Multiphase Flow, Kyoto (Japan). Sep 1995. (CONF-950904–Vol.4: 7. international meeting on nuclear reactor thermal hydraulics, Saratoga, NY (United States), 10-15 Sep 1995). In *Proceedings of the 7th International Meeting on Nuclear Reactor Thermal-Hydraulics NURETH-7. Sessions 17-24.* 825p. Source: OSTI; NTIS; INIS; GPO.

A program has been started for studying numerically boron mixing in the downcomer of Loviisa NPP (VVER-440). Mixing during the transport of a diluted slug from the loop to the core might serve as an inherent protection mechanism against severe reactivity accidents in inhomogenous boron dilution scenarios for PWRs. The commercial general purpose Computational Fluid Dynamics (CFD) core PHOENICS is used for solving the governing fluid flow equations in the downcomer geometry of VVER-440. So far numerical analyses have been performed for steady state operation conditions and two different pump driven transients. The steady state analyses focused on model development and validation against existing experimental data. The two pump driven transient scenarios reported are based on slug transport during the start of the sixth and first loop respectively. The results from the two transients show that mixing is case and plant specific; the high and open downcomer geometry of VVER-440 seems to be advantageous from mixing point of view. In addition the analyzing work for the "first pump start" scenario brought up some considerations about flow distribution in the existing experimental facilities.

29771 (NUREG/CP–0148) **Transactions of the twenty-third water reactor safety information meeting to be held at Bethesda Marriott Hotel, Bethesda, Maryland, October 23–25, 1995.** Monteleone, S. (comp.). Nuclear Regulatory Commission, Washington, DC (United States). Office of Nuclear Regulatory Research. Sep 1995. 163p. Sponsored by Nuclear Regulatory Commission, Washington, DC (United States). (CONF-9510156–: 23. water reactor safety information meeting, Bethesda, MD (United States), 23-25 Oct 1995). Source: OSTI; NTIS; INIS; GPO.

This report contains summaries of papers on reactor safety research to be presented at the 23rd Water Reactor Safety Information Meeting at the Bethesda Marriott Hotel, Bethesda, Maryland, October 23–25, 1995. The summaries briefly describe the programs and results of nuclear safety research sponsored by the Office of Nuclear Regulatory, Research, US NRC. Summaries of invited papers concerning nuclear safety issues from US government laboratories, the electric utilities, the nuclear industry, and from foreign governments and industry are also included. The summaries have been compiled in one report to provide a basis for meaningful discussion and information exchange during the course of the meeting and are given in the order of their presentation in each session.

29772 (NUREG/CR–5535-Vol.1) **RELAP5/MOD3 code manual: Code structure, system models, and solution methods. Volume 1.** Nuclear Regulatory Commission, Washington, DC (United States). Div. of Systems Technology; Lockheed Idaho Technologies Co., Idaho Falls, ID (United States). Aug 1995. 350p. Sponsored by Nuclear Regulatory Commission, Washington, DC (United States). DOE Contract AC07-76ID01570. (INEL–95/0174-Vol.1). Source: OSTI; NTIS; INIS; GPO.

The RELAP5 code has been developed for best estimate transient simulation of light water reactor coolant systems during postulated accidents. The code models the coupled behavior of the reactor coolant system and the core for loss-of-coolant accidents, and operational transients, such as anticipated transient without scram, loss of offsite power, loss of feedwater, and loss of flow. A generic modeling, approach is used that permits simulating a variety of thermal hydraulic systems. Control system and secondary system components are included to permit modeling of plant controls, turbines, condensers, and secondary feedwater systems. RELAP5/MOD3 code documentation is divided into seven volumes: Volume I provides modeling theory and associated numerical schemes.

29773 (NUREG/CR–5535-Vol.4) **RELAP5/MOD3 code manual. Volume 4, Models and correlations.** Nuclear Regulatory Commission, Washington, DC (United States). Div. of Systems Technology; Lockheed Idaho Technologies Co., Idaho Falls, ID (United States). Aug 1995. 300p. Sponsored by Nuclear Regulatory Commission, Washington, DC (United States). DOE Contract AC07-76ID01570. (INEL–95/0174-Vol.4). Source: OSTI; NTIS; INIS; GPO.

The RELAP5 code has been developed for best-estimate transient simulation of light water reactor coolant systems during postulated accidents. The code models the coupled behavior of the reactor coolant system and the core for loss-of-coolant accidents and operational transients such as anticipated transient without scram, loss of offsite power, loss of feedwater, and loss of flow. A generic modeling approach is used that permits simulating a variety of thermal hydraulic systems. Control system and secondary system components are included to permit modeling of plant controls, turbines, condensers, and secondary feedwater systems. RELAP5/MOD3 code documentation is divided into seven volumes: Volume I presents modeling theory and associated numerical schemes; Volume II details instructions for code application and input data preparation; Volume III presents the results of developmental assessment cases that demonstrate and verify the models used in the code; Volume IV discusses in detail RELAP5 models and correlations; Volume V presents guidelines that have evolved over the past several years through the use of the RELAP5 code; Volume VI discusses the numerical scheme used in RELAP5; and Volume VII presents a collection of independent assessment calculations.

29774 (NUREG/CR–6002) **Risk-based maintenance modeling. Prioritization of maintenance importances and quantification of maintenance effectiveness.** Vesely, W.E. (Science Applications International Corp., Dublin, OH (United States)); Rezos, J.T. Nuclear Regulatory Commission, Washington, DC (United States). Div. of Systems Technology; Brookhaven National Lab., Upton, NY (United States); Science Applications International Corp., Dublin, OH (United States). Sep 1995. 70p. Sponsored by Nuclear Regulatory Commission, Washington, DC (United States). DOE Contract AC02-76CH00016. (BNL-NUREG–52332). Source: OSTI; NTIS; INIS; GPO.

This report describes methods for prioritizing the risk importances of maintenances using a Probabilistic Risk Assessment (PRA). Approaches then are described for quantifying their reliability and risk effects. Two different PRA importance measures, minimal cutset importances and risk reduction importances, were used to prioritize maintenances; the findings show that both give similar results if appropriate criteria are used. The justifications for the particular importance measures also are developed. The methods developed to quantify the reliability and risk effects of maintenance actions are extensions of the usual reliability models now used in PRAs. These extended models consider degraded states of the component, and quantify the benefits of maintenance in correcting degradations and preventing failures. The negative effects of maintenance, including downtimes, also are included. These models are specific types of Markov models. The data for these models can be obtained from plant maintenance logs and from the Nuclear Plant Reliability Data System (NPRDS). To explore the potential usefulness of these models, the authors analyzed a range of postulated values of input data. These models were used to examine maintenance effects on a components reliability and performance for various maintenance programs and component data. Maintenance schedules were analyzed to optimize the component's availability. In specific cases, the effects of maintenance were found to be large.

29775 (NUREG/CR–6017) **Fire modeling of the Heiss Dampf Reaktor containment.** Nicolette, V.F. (Sandia National Labs., Albuquerque, NM (United States)); Yang, K.T. Nuclear Regulatory Commission, Washington, DC (United States). Div. of Engineering Technology. Sep 1995. 120p. Sponsored by Nuclear Regulatory Commission, Washington, DC (United States). (SAND–93-0528). Source: OSTI; NTIS; INIS; GPO.

This report summarizes Sandia National Laboratories' participation in the fire modeling activities for the German Heiss Dampf Reaktor (HDR) containment building, under the sponsorship of the United States Nuclear Regulatory Commission. The purpose of this report is twofold: (1) to summarize Sandia's participation in the HDR fire modeling efforts and (2) to summarize the results of the international fire modeling community involved in modeling the

HDR fire tests. Additional comments, on the state of fire modeling and trends in the international fire modeling community are also included. It is noted that, although the trend internationally in fire modeling is toward the development of the more complex fire field models, each type of fire model has something to contribute to the understanding of fires in nuclear power plants.

29776 (NUREG/CR–6265) **Multidisciplinary framework for human reliability analysis with an application to errors of commission and dependencies.** Barriere, M.T. (Brookhaven National Lab., Upton, NY (United States)); Luckas, W.J.; Wreathall, J.; Cooper, S.E.; Bley, D.C.; Ramey-Smith, A. Nuclear Regulatory Commission, Washington, DC (United States). Div. of Systems Technology; Brookhaven National Lab., Upton, NY (United States); Wreathall (John) and Co., Dublin, OH (United States); Science Applications International Corp., Reston, VA (United States); PLG, Inc., Newport Beach, CA (United States). Aug 1995. 150p. Sponsored by Nuclear Regulatory Commission, Washington, DC (United States). DOE Contract AC02-76CH00016. (BNL-NUREG–52431). Source: OSTI; NTIS; INIS; GPO.

Since the early 1970s, human reliability analysis (HRA) has been considered to be an integral part of probabilistic risk assessments (PRAs). Nuclear power plant (NPP) events, from Three Mile Island through the mid-1980s, showed the importance of human performance to NPP risk. Recent events demonstrate that human performance continues to be a dominant source of risk. In light of these observations, the current limitations of existing HRA approaches become apparent when the role of humans is examined explicitly in the context of real NPP events. The development of new or improved HRA methodologies to more realistically represent human performance is recognized by the Nuclear Regulatory Commission (NRC) as a necessary means to increase the utility of PRAS. To accomplish this objective, an Improved HRA Project, sponsored by the NRC's Office of Nuclear Regulatory Research (RES), was initiated in late February, 1992, at Brookhaven National Laboratory (BNL) to develop an improved method for HRA that more realistically assesses the human contribution to plant risk and can be fully integrated with PRA. This report describes the research efforts including the development of a multidisciplinary HRA framework, the characterization and representation of errors of commission, and an approach for addressing human dependencies. The implications of the research and necessary requirements for further development also are discussed.

29777 (PNL–10741) **Effectiveness of storage practices in mitigating aging degradation during reactor layup.** Enderlin, W.I. Pacific Northwest Lab., Richland, WA (United States). Sep 1995. 30p. Sponsored by Nuclear Regulatory Commission, Washington, DC (United States). DOE Contract AC06-76RL01830. Order Number DE96000730. Source: OSTI; NTIS; INIS; GPO Dep.

One of the issues identified in the US Nuclear Regulatory Commission's Nuclear Plant Aging Research program plan is the need to understand the state of "mothballed" or other out-of-service equipment to ensure subsequent safe operation. Programs for proper storage and preservation of materials and components are required by NRC regulations (10 CFR 50, Appendix B). However, materials and components have been seriously degraded due to improper storage, protection, or layup, at facilities under construction as well as those with operating licenses. Pacific Northwest Laboratory has evaluated management of aging for unstarted or mothballed nuclear power plants. The investigations revealed that no uniform guidance in the industry addresses reactor layup. In each case investigated, layup was not initiated in a timely manner, primarily because of schedule uncertainty. Hence, it is reasonable to assume that this delay resulted in accelerated aging of some safety-significant structures, systems, and components (SSCs). The applicable layup process is site-specific. The reactor type, climatic setting, operational status, and materials of construction are factors that strongly dictate the layup method to be used. The adequacy of current layup practices, and hence their impact on safety-significant SSCS, is not fully understood.

29778 (UCRL-JC–120805) **Determination of controlling earthquakes from probabilistic seismic hazard analysis for nuclear reactor sites.** Boissonnade, A. (Lawrence Livermore National Lab., CA (United States)); Bernreuter, D.; Chokshi, N.; Murphy, A. Lawrence Livermore National Lab., CA (United States). 4 Apr 1995. 8p. Sponsored by USDOE, Washington, DC (United States). DOE Contract W-7405-ENG-48. (CONF-950804–9: 13. international conference on structural mechanics in reactor technology, Porto Alegre (Brazil), 13-18 Aug 1995). Order Number DE95017900. Source: OSTI; NTIS; GPO Dep.

Recently, the US Nuclear Regulatory Commission published, for public comments, a revision to 10 CFR Part 100. The proposed regulation acknowledges that uncertainties are inherent in estimates of the Safe Shutdown Earthquake Ground Motion (SSE) and requires that these uncertainties be addressed through an appropriate analysis. One element of this evaluation is the assessment of the controlling earthquake through the probabilistic seismic hazard analysis (PSHA) and its use in determining the SSE. This paper reviews the basis for the various key choices in characterizing the controlling earthquake.

24 POWER TRANSMISSION AND DISTRIBUTION

Refer also to citation(s) 29789, 29790

29779 (KRC–91S-S05) **Power Line Carrier Relay System : Analysis and Correction of the Trip Blocking Malfunction.** Kim, I.D. (Korea Electric Power Corp. (KEPCO), Taejon (Korea, Republic of). Research Center); Park, S.T.; Chang, B.T.; Yu, H.J.; Cho, H.K.; Lee, H.K.; Cho, K.B.; Kim, K.N.; Choi, S.K. Korea Electric Power Corp. (KEPCO), Taejon (Korea, Republic of). Research Center. 1994. 671p. (In Korean). Order Number DE96703607. Source: OSTI; NTIS (US Sales Only).

For many years in KEPCO power system, mistripping of the power line carrier relay has been an obstacle to keep high quality of electric power supply. The power line carrier (PLC) relaying scheme has widely applied to 154kV and 345kV transmission network as a main protective scheme since the beginning of high voltage network at the end of the 60's. The mistripping, Which means an unwanted circuit breaker (CB) tripping caused by malfunction of the relay system during external faults, has become major reason of percentage failure as the network is getting complicated. Thirty to forth percentage of total mistripping of protective relay was due to the PLC relay, nevertheless there was no active technical analysis and investigation to get proper countermeasure. On the other hand, it is true that the investigation of malfunction of the PLC replay is very difficult because the relay system is complex and has to operate only in cas of special circumstances such as line faults or extremely abnormal conditions. The objective of this study is to find origins of the PLC relay malfunction and to develop countermeasures in order to increase the reliability of system protection by means of positively strong investigation. (author). 22 refs., fig.

2401 Power Systems

Refer also to citation(s) 29400, 29792

29780 (KRC–91S-J03) **Research on Master Plan of Power System Simulator Installation.** Kwon, T.W. (Korea Electric Power Corp. (KEPCO), Taejon (Korea, Republic of). Research Center); Yoon, Y.B.; Lee, C.H.; Lee, K.J.; Kim, J.H.; Shin, J.L.; Kim, K.C.; Lee, H.J.; Sim, K.B.; Park, D.S.; Moon, Y.H.; Choi, S.M.; Chung, S.K. Korea Electric Power Corp. (KEPCO), Taejon (Korea, Republic of). Research Center. 1993. 758p. (In Korean). Order Number DE96703608. Source: OSTI; NTIS (US Sales Only).

Considering the limited power-plant sites and transmission lines, the rapid increase in demand of electric energy needs huge electric sources, and cause the highly dense transmission power. Since power systems are required to play more important roles in the aspects of both supply and demand of electric energy, the exact analysis of power systems phenomena is essential for its stability. Both digital computers and simulators are used popularly to analyze the phenomena of power systems, Because of its merit and demerit. But until now, we analyze the phenomena only using the digital computers. So, we have performed the feasibility study for installing the power system simulator in KEPCO.

29781 (KRC–91S-S02) **A Study on the Design of the Integrated Systems for Power System Operational Planning and Analysis.** Kwan, T.W. (Korea Electric Power Corp. (KEPCO), Taejon (Korea, Republic of). Research Center); Lee, B.H.; Ham, W.K.; Lee, K.J. Korea Electric Power Corp. (KEPCO), Taejon (Korea, Republic of). Research Center. 1993. 553p. (In Korean). Order Number DE96703609. Source: OSTI; NTIS (US Sales Only).

Integrated System for Power System Operational Planning and Analysis is a totally integrated computerized system for power system planning and operations. Conditions, pertaining to power supply, such as maintenance of stability, fuel and environmental constraints, and trends toward increasing supply costs, are getting more involved. Planning quality and immediate responses in business are of great significance to operations under such circumstances. In addition, plan that deviates from operations seriously affect management. For these reasons power supply planning is required to be fully in accordance with actual operations and to be highly accurate. To facilitate such planning, it is necessary to carry out an hour by hour simulation over a period of a full year(8760 hours). Besides the power supply planning system, a lot of computer programs for performing load forecasting, generator maintenance scheduling, and power system analysis are included in the Integrated System. Since the work carried out by these programs are performed by a number of departments and sections of a utility company and require an enormous flow of information, the Highly Integrated System to integrate the programs into one system and to form a unified database should be very useful to improve their efficiencies. In this study as a feasibility study of the Highly Integrated System, the basic design and foundation for developing the actual highly integrated system are provided.

29782 (LBL–34772-Rev.) **The transmission interface constraint problem. Revision.** Baldick, R.; Kahn, E. Lawrence Berkeley Lab., CA (United States). Oct 1994. 24p. Sponsored by USDOE, Washington, DC (United States). DOE Contract AC03-76SF00098. Order Number DE96000872. Source: OSTI; NTIS; GPO Dep.

Electric power transmission systems exhibit a number of complex constraints on their operation and usage. When a network is subject to a constraint that limits the amount of power that can be moved from one region to another, there is said to be an interface limit. The power systems literature gives no general treatment of the engineering-economics of this ubiquitous phenomenon. Particular aspects of interface limits are typically discussed in sophisticated technical detail, but the general engineering-economic trade-offs involved in relieving interface constraints have not been systematically addressed. We approach this problem in the spirit of a heuristic model. Such models are quite valuable under current industry conditions because they delineate technical opportunities and choices in situations where there may be conflicting views among competing parties and regulatory authorities. We organize and enumerate the choices, clarify the practical conditions that dictate the optimum in particular cases, and help to motivate the final choices made by planners.

2402 Power System Networks, Transmission and Distribution

Refer also to citation(s) 29779, 29780

29783 (CONF-9509212–1) **Multilevel converters for power system applications.** Lai, J.S. (Oak Ridge National Lab., TN (United States)); Stovall, J.P.; Peng, F.Z. Oak Ridge National Lab., TN (United States). [1995]. 10p. Sponsored by USDOE, Washington, DC (United States). DOE Contract AC05-84OR21400. From Cigre study committee 14 colloquim; Montreal (Canada); 18-19 Sep 1995. Order Number DE95017388. Source: OSTI; NTIS; GPO Dep.

Multilevel converters are emerging as a new breed of power converter options for power system applications. These converters are most suitable for high voltage high power applications because they connect devices in series without the need for component matching. One of the major limitations of the multilevel converters is the voltage unbalance between different levels. To avoid voltage unbalance between different levels, several techniques have been proposed for different applications. Excluding magnetic-coupled converters, this paper introduces three multilevel voltage source converters: (1) diode-clamp, (2) flying-capacitors, and (3) cascaded inverters with separate dc sources. The operation principle, features, constraints, and potential applications of these converters will be discussed.

29784 (CONF-9510203–4) **A multilevel voltage-source inverter with separate dc sources for static var generation.** Peng, Fang Zheng (Tennessee Univ., Knoxville, TN (United States)); Lai, Jih-Sheng; McKeever, J.; VanCoevering, J. Oak Ridge National Lab., TN (United States). [1995]. 8p. Sponsored by USDOE, Washington, DC (United States). DOE Contract AC05-84OR21400. From IEEE/Industrial Application Society conference; Orlando, FL (United States); 8-12 Oct 1995. Order Number DE95017452. Source: OSTI; NTIS; GPO Dep.

A new multilevel voltage-source inverter with a separate dc sources is proposed for high-voltage, high-power applications, such as flexible ac transmission systems (FACTS) including static var generation (SVG), power line conditioning, series compensation, phase shifting, voltage balancing, fuel cell and photovoltaic utility systems interfacing, etc. The new M-level inverter consists of (M-1)/2 single phase full bridges in which each bridge has its own separate dc source. This inverter can generate almost sinusoidal waveform voltage with only one time switching per cycle as the number of levels increases. It can solve the problems of conventional transformer-based multipulse inverters and the problems of the multilevel diode-clamped inverter and the multilevel flying capacitor inverter. To demonstrate the superiority of the new inverter, a SVG system using the new inverter topology is discussed through analysis, simulation and experiment.

29785 (KRC–91D-J01) **A Study of the Establishment of Algorithm and the Standardization for Distribution Automation.** Ko, I.S. (Korea Electric Power Corp. (KEPCO), Taejon (Korea, Republic of). Research Center); Song, B.K.; Hong, S.H.; Chang, J.T.; Ha, B.N.; Kim, Y.R.; Song, I.G.; Choi, B.Y.; Kim, H.Y.; Namm, K.Y.; Kim, W.T.; Chung, K.H.; Ko, Y.S.; No, J.K.; Kim, E.S.; SeoKorea Electric Power Corp. (KEPCO), Taejon (Korea, Republic of). Research Center. 1993. 544p. (In Korean). Order Number DE96703579. Source: OSTI; NTIS (US Sales Only).

Before developing or applicating the distribution automation system, KEPCO needs to analyze his distribution system and establishes his system operation algorithm and defines the system specification. This report includes the proper switching method and protective coordination, the distribution automation algorithm, specific technology analysis, the method of system selection and organization, economic feasibility and system standardization. (author). 57 refs., figs.

29786 (KRC–92S-J08) **A Study on the Protective Relaying Schemes for 765kV Power System.** Kim, I.D. (Korea Electric Power Corp. (KEPCO), Taejon (Korea, Republic of). Research Center); Park, S.T.; Namkung, D.; Chang, B.T.; Yu, H.J.; Sher, S.K.; Shin, D.S.; Oh, T.K.; Moon, Y.H.; Lee, Y.H.; Kim, T.K.; Sher, E.S.; Choi, K.S. Korea Electric Power Corp. (KEPCO), Taejon (Korea, Republic of). Research Center. 1994. 400p. (In Korean). Order Number DE96703605. Source: OSTI; NTIS (US Sales Only).

To Meet increasing power demand, 765kV transmission system is scheduled to operate from the year of 2,002. As the new 765kV system carry can bulk power, some severe fault on the system may cause large system disturbance. Therefore protective relaying of 765kV system have to be more sensitive, speedy and reliable than that of existing 345kV system. On the other hand, the large shunt capacitance and small resistance of 765kV transmission line make various difficulties for its protection. These problems including current difference between sending and receiving terminals on normal power flow, low order harmonic current component in fault current and current transformer saturation due to the long dc time constant of the circuit etc. must be investigated and solved. The necessity of this study is to select an adequate protective relaying for 765kV system in order to maintain stable and efficient of the future system. (author). 397 refs., fig.

29787 (MLM-MU–89-62-0004) **Design criteria for OSW alternate power.** Saul, W.A. EG and G Mound Applied Technologies, Miamisburg, OH (United States). Jan 1989. 50p. Sponsored by

USDOE, Washington, DC (United States). DOE Contract AC24-88DP43495. Order Number DE96000802. Source: OSTI; NTIS; GPO Dep.

The purpose of this project is threefold. First to provide a reliable and more continuous source of electrical power to the Operational Support Building-West (OSW) in order to better serve Mound financial and CAD computer facilities. This increased reliability shall be accomplished by the installation of a tie breaker that will connect the 480 volt secondary of the OSW substation with the 480 volt secondary of B substation, within 200 feet of the building. The OSW substation is in the penthouse of the four (4) story OSW building. The B substation is outside along the plant roadway. Installation of the tie breaker will also permit work to be done on the primary (12,470 volt) side of the transformer without a shutdown of the building. Secondly, the replacement of the OSW substation PCB transformer shall be done in order to eliminate the risk of a fire spreading PCB vapors to the building ventilation system. Thirdly, the replacement of the switchboard on the 480 volt secondary of the OSW substation with more reliable breakers. Also, the existing switches do not allow expansion of the 480 volt supply to building equipment. One of the new breakers shall supply power to a new power panel, thus providing breaker space for installation of new equipment.

29788 (PNL-SA–25692) **Impacts of the distributed utility on transmission system stability.** Donnelly, M.K. (Pacific Northwest Lab., Richland, WA (United States)); Dagle, J.E.; Trudnowski, D.J.; Rogers, G.J. Pacific Northwest Lab., Richland, WA (United States). Jul 1995. 10p. Sponsored by USDOE, Washington, DC (United States). DOE Contract AC06-76RL01830. (CONF-950727–3: Summer meeting of the IEEE Power Engineering Society, Portland, OR (United States), 23-27 Jul 1995). Order Number DE95016799. Source: OSTI; NTIS; GPO Dep.

The distributed (or dispersed) utility concept is rapidly becoming a reality in some service areas. In this framework, modular generation and storage assets along with selected demand-side management programs are used in place of the more traditional infrastructure upgrades to ensure reliable service to a group of utility customers. From among the many technical challenges associated with the proliferation of distributed resources, this paper deals with the impacts of distributed architectures upon the bulk transmission system. Bulk transmission system transient and small-signal stability are addressed through the use of extensive case studies. Planning tools and methods are discussed, and some general conclusions related to stability issues are drawn.

2403 Power Transmission Lines and Cables

29789 (KRC–91D-J03) **A Study on the Thermal Rating of Underground Distribution Cable by Dynamic Modelling.** Moon, B.H. (Korea Electric Power Corp. (KEPCO), Taejon (Korea, Republic of). Research Center); Chung, D.W.; Lee, N.W.; Kim, D.K.; Kang, D.S.; Kang, D.H.; Choi, S.B.; Chung, S.H.; Kim, S.S.; Park, S.J.; Cho, Y.K. Korea Electric Power Corp. (KEPCO), Taejon (Korea, Republic of). Research Center. 1993. 263p. (In Korean). Order Number DE96703580. Source: OSTI; NTIS (US Sales Only).

The objects of this study are to revaluate the ampacity of distribution cables by using existing steady state analysis method, and suggest new ampacity calculation method using dynamic modelling as one of ampacity increase. The results of the steady state rating will be used as the operation guide of continuous rating for the underground distribution system, and the dynamic rating will be applicative to operation guide of emergency ratings. (author). 11 refs., figs.

29790 (KRC–91S-J04) **A Study on the Protective of Underground Transmission Cable from Electrical Surges.** Lee, K.S. (Korea Electric Power Corp. (KEPCO), Taejon (Korea, Republic of). Research Center); Chang, J.K.; Seo, J.Y.; Namkung, D.; Park, J.S.; Choi, I.H.; Hwang, C.W.; Shin, D.S.; Chung, D.H.; Yoon, J.Y.; Choi, K.H.; Lee, H.K.; Whi, S.B.; Son, H.K.; Ann, HKorea Electric Power Corp. (KEPCO), Taejon (Korea, Republic of). Research Center. 1993. 172p. (In Korean). Order Number DE96703606. Source: OSTI; NTIS (US Sales Only).

The need of underground transmission system and GIS substation is increasing because of their high reliabilities, easiness to get right of ways. Underground power systems usually Show rare faults record compared with overhead power systems, but if trouble take place, it will develop to permanent fault, and the damage will be large scale taking a lot of time and cost for repairing. As a result, we should pay much obtention to design and operation of underground power system. In our case, a few conceptual studies of the effects of surges on power systems were conducted, but practical studies of overvoltage generation and countermeasure against overvoltage have not been carried out. Consequently, most of the countermeasures and guidances for overvoltage problem were adopted from foreign sources. In this study, Overvoltage in power cables, GIS substations and metallic sheath were simulated by EMTP. based on the simulation results, proper countermeasures against overvoltage were presented. (author). 37 refs., fig.

2405 Environmental Aspects

Refer also to citation(s) 31289

29791 (DOE/EIS–0166) **Final environmental impact statement for construction and operation of the proposed Bangor Hydro-Electric Company's second 345-kV transmission tie line to New Brunswick.** USDOE Assistant Secretary for Fossil Energy, Washington, DC (United States). Office of Fuels Programs. Aug 1995. 200p. Sponsored by USDOE, Washington, DC (United States). Order Number DE95017712. Source: OSTI; NTIS; INIS; GPO Dep.

The proposed action is the issuance of Presidential Permit PP-89 by the US Department of Energy (DOE) to Bangor Hydro-Electric Company (BHE) to operate its second international electrical power transmission interconnection with New Brunswick, Canada, at normal operating power levels of 500 megawatts (MW) and to construct new transmission facilities to distribute this power. The proposed transmission line is needed to (1) complement and share electrical load with the existing 345-kilovolt (kV) interconnection (which would result in conservation of up to 24 MW annually), (2) enhance the sharing of generation between New England and New Brunswick (thereby reducing reserve generation requirements by sharing capacity during emergencies), and (3) increase the reliability of the overall transmission system. The availability of the additional electricity would have a beneficial effect on the economy and should enhance continued residential, industrial, and economic growth and improvement in the service area, the state of Maine, and New England. The proposed new facilities, referred to as the second 345-kV tie line to New Brunswick, consist of two principal elements. The first, and major, element is the proposed construction of an 83.8-mile-long, alternating current (AC) transmission line that would cross the US-Canadian border at Baileyville, Maine, and continue southwest to Orrington, Maine. The second element involves the proposed expansion of the existing substation at Orrington to accommodate the new 345-kV AC transmission line. Two other substations would also be upgraded to accommodate the new power loads throughout the system. ca. 300 refs., 30 figs., 39 tabs.

2407 Economic, Industrial, and Business Aspects

Refer also to citation(s) 29876

29792 (CONF-9408169–8) **Recent program evaluations: Implications for long-run planning.** Baxter, L.W. (Oak Ridge National Lab., TN (United States)); Schultz, D.K. Oak Ridge National Lab., TN (United States). 8 Jun 1994. 13p. Sponsored by USDOE, Washington, DC (United States). DOE Contract AC05-84OR21400. From American Council for Energy-Efficient Economy (ACEEE) summer conference; Asilomar, CA (United States); 28 Aug - 3 sep 1994. Order Number DE95014036. Source: OSTI; NTIS; GPO Dep.

Demand-side management (DSM) remains the centerpiece of California's energy policy. Over the coming decade, California plans to meet 30 percent of the state's incremental electricity demand and 50 percent of its peak demand with (DSM) programs. The major investor-owned utilities in California recently completed the first round of program impact studies for energy efficiency programs implemented in 1990 and 1991. The central focus of this

paper is to assess the resource planning and policy implications of Pacific Gas and Electric (PG&E) Company's recent program evaluations. The paper has three goals. First, we identify and discuss major issues that surfaced from our attempt to apply evaluation results to forecasting and planning questions. Second, we review and summarize the evaluation results for PG&E's primary energy efficiency programs. Third, we change long-run program assumptions, based on our assessment in the second task, and then examine the impacts of these changes on a recent PG&E demand-side management forecast and resource plan.

29793 (INIS-BR–3548) **Resources transfer and centralization in Brazilian electrical sector: the reversion global reserve (RGR) and the guarantee global reserve (GGR).** Souza Amaral Filho, J.B. de. Universidade Estadual de Campinas, SP (Brazil). Inst. de Economia. 1991. 324p. (In Portuguese). Order Number DE96602780. Source: OSTI; NTIS; INIS.

This dissertation makes the analysis of resources transfer and centralization in Brazilian electrical sector, through reversion global reserve (RGR) and guarantee global reserve (GGR). RGR and GGR are funds. RGR finances sectorial investments in electric power and GGR aims the supply of deficient concessionaires. Governmental investments and the results of this application are showing. (M.V.M.). 55 refs, 2 figs, 61 tabs.

29794 (INIS-BR–3550) **Economic growth and energy demand in Brazil from 1930 to 1980.** Theis, I.M. Santa Catarina Univ., Florianopolis, SC (Brazil). Oct 1988. 445p. (In Portuguese). Order Number DE96602781. Source: OSTI; NTIS; INIS.

There are enough evidences that economic growth and energy demand are closely related indeed. These evidences show that the growth of the economic activity calls for greater energy inputs. The Brazilian case is similar to the other industrialized economies, in spite of our industrialization process being started only in the 1930. Two periods excelled as phases of quick and accelerated growth of the Economic Product: the later fifties and the famous miracle from 1968 to 1973. During those periods the demand for energy in Brazil increased to amounts previously unthinkable. More remarkable, however, is that, after those phases of accelerated growth, Brazilian economy had changed the consumption profile considerably: while, until 1968 firewood was the most important resource, since then petroleum has taken this position. (author). 213 refs, 115 tabs.

29795 (INIS-BR–3552) **The new tariff model based on marginal costs developing concept for Brazilian electric sector. A case study for Power and Light Company of Sao Paulo State (Brazil).** Correia, S.P.S. Universidade Estadual de Campinas, SP (Brazil). Faculdade de Engenharia. 1991. 98p. (In Portuguese). Order Number DE96602782. Source: OSTI; NTIS; INIS.

A new methodology for power generation cost accounts in Brazilian electric sector is described, with the application of marginal costs theory and its deviation in developing economies. A case report from a Brazilian Power and Light Company is studied, focalizing the seasoning, the planning, the tariff model and the power generation, transmission and distribution. (M.V.M.). 19 refs, 28 figs, 1 tab.

25 ENERGY STORAGE

2501 Magnetic

Refer also to citation(s) 31149

2504 Capacitor Banks

29796 (ETDE/CH-mf–95787322, pp. 27-29) **Activated glassy carbon as a supercapacitor material.** Sullivan, M. (Paul Scherrer Inst. (PSI), Villigen (Switzerland)); Koetz, R.; Haas, O. Paul Scherrer Inst. (PSI), Villigen (Switzerland). 1995. In *Paul Scherrer Institut annual report 1994. Annex V: PSI general energy technology newsletter 1994.* 123p. Source: OSTI; NTIS.

Electrochemical activation of glassy carbon in 3 M H_2SO_4 produces a surface which exhibits a large interfacial (double-layer type) capacitance. Using a single electrode measurement technique, capacitances up to 0.75 F/cm^2 have been reached. AC impedance spectroscopy reveals that the internal resistance of the capacitor is not increased by the anodic modification process, and that diffusion (formation of concentration gradients) does not seem to be a limiting process in the transport of charge within the capacitor materials. Large capacitance persists if the electrolyte solution is changed to 1 M $LiClO_4$ in acetonitrile, but the single electrode capacitance typically falls to about 1/2 the value measured in acid solution. The maximum cell voltage of capacitors using the acetonitrile based electrolyte rather than aqueous acid is larger by at least a factor of 3, but the internal resistance is significantly greater than that of the aqueous system. (author) 4 figs., 4 refs.

2506 Thermal

Refer also to citation(s) 29402, 29866, 29896, 29897, 29924

29797 (CONF-890351–, pp. 26-57) **Evaporative heat transfer in beds of sensible heat pellets.** Arimilli, R.V. (Univ. of Tennessee, Knoxville, TN (United States)); Moy, C.A. USDOE Assistant Secretary for Conservation and Renewable Energy, Washington, DC (United States). Office of Energy Management; Pacific Northwest Lab., Richland, WA (United States); Oak Ridge National Lab., TN (United States). Mar 1989. From Thermal energy storage program review; New Orleans, LA (United States); 15-17 Mar 1989. In *U.S. Department of Energy thermal energy storage research activities review: 1989 Proceedings.* 357p. Order Number DE95016394. Source: OSTI; NTIS; GPO Dep.

An experimental study of boiling/evaporative heat transfer from heated spheres in vertical packed beds with downward liquid-vapor flow of Refrigerant-113 was conducted. Surface superheats of 1 to 50°C, mass flow rates of 1.7 to 5.6 Kg/min, sphere diameters of 1.59 and 2.54 cm, quality (i.e., mass fraction of vapor) of the inlet flow of 0.02 to 1.0, and two surface conditions were considered. Instrumented smooth and rough aluminum spheres were used to measure the heat transfer coefficients under steady state conditions. Heat transfer coefficients were independently determined for each sphere at three values three values of surface superheat. The quantitative results of this extensive experimental study are successfully correlated. The correlation equation for the boiling heat transfer coefficients is presented in terms of a homogeneous model. The correlation may be used in the development of numerical models to simulate the transient thermal performance of packed bed thermal energy storage unit while operating as an evaporator. The boiling of the liquid-vapor flow around the spheres in the packed bed was visually observed with a fiber-optic baroscope and recorded on a videotape. The visualization results showed qualitatively the presence of four distinct flow regimes. One of these occurs under saturated inlet conditions and are referred to as the Low-quality, Medium-quality, and High-quality Regimes. The regimes are discussed in detail in this paper.

29798 (CONF-890351–, pp. 58-74) **Effect of dopants on crystal structure and thermal properties of pentaglycerine.** Chandra, D. (Univ. of Nevada, Reno, NV (United States)); Ding, W. USDOE Assistant Secretary for Conservation and Renewable Energy, Washington, DC (United States). Office of Energy Management; Pacific Northwest Lab., Richland, WA (United States); Oak Ridge National Lab., TN (United States). Mar 1989. From Thermal energy storage program review; New Orleans, LA (United States); 15-17 Mar 1989. In *U.S. Department of Energy thermal energy storage research activities review: 1989 Proceedings.* 357p. Order Number DE95016394. Source: OSTI; NTIS; GPO Dep.

The overall objective of this research program is to develop practical solid-state thermal energy storage materials. Research is focused on polyalcohol "Plastic Crystals" which undergo crystallographic changes at constant transition temperature absorbing or releasing amounts of latent heat. The known pure polyalcohols have high transition temperatures; therefore, adjustment of transformation temperature is important to develop practical materials. The approach taken is to introduce substitutional and interstitial dopants so as to strain the lattice of the host crystal which results in lowering the transition temperature. Current research is on temperature adjustment of pentaglycerine [PG] ($C_5H_{12}O_3$) initiated

approximately four months ago. Results, so far, show that the substitutional dopants are more effective in reducing the transition temperature than interstitial dopants. The results in the first phase of this program show that the transition temperature of PG reduced significantly by using trimethylol propane [TMP] ($C_6H_{14}O_3$), 2-amino 2-methyl 1,3 propanediol [AMPL] ($C_4H_{11}NO_2$) as dopants. It appears that some of these doped samples have near room temperature transitions; however, these results are not conclusive at this time. Recently, it was discovered that TMP has an additional solid-solid phase transformation, slightly below room temperature. Crystal structure analyses showed some surprising results with regards to thermal expansion behavior of PG. Several sets of low as well as high temperature data were obtained from the pure and doped PG to characterize the structural changes, if any, and the thermal expansions. Research is in progress on crystal structure and thermal analyses.

29799 (CONF-890351–, pp. 92) **Development of separation techniques for a direct contact thermal energy storage system.** Min, T.C. (North Carolina A&T State Univ., Greensboro, NC (United States)); Tomlinson, J.J. USDOE Assistant Secretary for Conservation and Renewable Energy, Washington, DC (United States). Office of Energy Management; Pacific Northwest Lab., Richland, WA (United States); Oak Ridge National Lab., TN (United States). Mar 1989. From Thermal energy storage program review; New Orleans, LA (United States); 15-17 Mar 1989. In *U.S. Department of Energy thermal energy storage research activities review: 1989 Proceedings.* 357p. Order Number DE95016394. Source: OSTI; NTIS; GPO Dep.

In direct contact ice-making processes, the refrigerant will pick up water vapor through direct percolation and oil from the compressor. The purpose of this project is to investigate methods for separating water vapor and oil from a mixture to complete a refrigeration cycle. In this paper, we report critical review on two separation techniques. From a literature search, we have identified a third technique; and plan to evaluate this method by bench-scale experiments. A recommendation for future work is included.

29800 (CONF-890351–, pp. 93-96) **Development of a direct contact ice storage system.** Poirier, R. (Chicago Bridge & Iron Company, Plainfield, IL (United States)). USDOE Assistant Secretary for Conservation and Renewable Energy, Washington, DC (United States). Office of Energy Management; Pacific Northwest Lab., Richland, WA (United States); Oak Ridge National Lab., TN (United States). Mar 1989. From Thermal energy storage program review; New Orleans, LA (United States); 15-17 Mar 1989. In *U.S. Department of Energy thermal energy storage research activities review: 1989 Proceedings.* 357p. Order Number DE95016394. Source: OSTI; NTIS; GPO Dep.

The program described involves the design, construction, and performance testing of a Direct Freeze Thermal Energy Storage System. Task 1 (Design) has been completed; and Task 2 (construction) is in progress, with equipment procurements presently underway. Once constructed, the system will undergo extensive laboratory performance testing and analysis, followed by an assessment of the system's cost effectiveness. This study will advance the understanding and development of the direct freeze concept, which offers inherent benefits for thermal energy storage.

29801 (CONF-890351–, pp. 128-144) **Self-releasing submerged ice maker.** Stewart, W.E. Jr. (Univ. of Missouri-Columbia, Independence, MO (United States)); Greer, M.E.; Stickler, L.A. USDOE Assistant Secretary for Conservation and Renewable Energy, Washington, DC (United States). Office of Energy Management; Pacific Northwest Lab., Richland, WA (United States); Oak Ridge National Lab., TN (United States). Mar 1989. From Thermal energy storage program review; New Orleans, LA (United States); 15-17 Mar 1989. In *U.S. Department of Energy thermal energy storage research activities review: 1989 Proceedings.* 357p. Order Number DE95016394. Source: OSTI; NTIS; GPO Dep.

This study reports the results of a series of experiments which investigated a thermal storage technology whereby slush ice is grown on a submerged cold surface and the resultant growth of slush ice released without auxiliary thermal or mechanical means. The process investigated consists of growing slush ice from an electrolyte solution of low molarity. The cold surface (substrate) upon which the slush ice forms is submerged in the bulk solution. As the buoyancy force on the ice crystals exceeds the adhesion to the cold surface, the slush ice is forced from the substrate and floats away, to the top of the solution. The results of this study reveal the relative insensitivity of the growth rate of ice crystals to solution initial bulk concentration over the range of values tested and to concentration of electrolyte during accumulation of ice crystals. The critical parameter appears to be substrate temperature, which generally cannot be less than approximately 2°C below the freezing point temperature of the solution, as apparent adhesion increases rapidly with decreasing substrate temperature.

29802 (CONF-890351–, pp. 145-170) **Thermal energy storage with liquid-liquid systems.** Santana, E.A. (Polytechnic Univ., Brooklyn, NY (United States)); Stiel, L.I. USDOE Assistant Secretary for Conservation and Renewable Energy, Washington, DC (United States). Office of Energy Management; Pacific Northwest Lab., Richland, WA (United States); Oak Ridge National Lab., TN (United States). Mar 1989. From Thermal energy storage program review; New Orleans, LA (United States); 15-17 Mar 1989. In *U.S. Department of Energy thermal energy storage research activities review: 1989 Proceedings.* 357p. Order Number DE95016394. Source: OSTI; NTIS; GPO Dep.

The use of liquid-liquid mixtures for heat and cool storage applications has been investigated. Suitable mixtures exhibit large changes in the heat of mixing above and below the critical solution temperature of the system. Analytical procedures have been utilized to determine potential energy storage capabilities of systems with upper or lower critical solution temperatures. It has been found that aqueous systems with lower critical solution temperatures in a suitable range can result in large increases in the effective heat capacity in the critical region. For cool storage with a system of this type, the cooling process results in a transformation from two liquid phases to a single phase. Heats of mixing have been measured with a flow calorimeter system for a number of potential mixtures, and the results are summarized.

29803 (CONF-890351–, pp. 172-196) **Simulation of a high temperature thermal energy storage system employing several families of phase-change storage material.** Adebiyi, G.A. (Mississippi State Univ., MS (United States)). USDOE Assistant Secretary for Conservation and Renewable Energy, Washington, DC (United States). Office of Energy Management; Pacific Northwest Lab., Richland, WA (United States); Oak Ridge National Lab., TN (United States). Mar 1989. From Thermal energy storage program review; New Orleans, LA (United States); 15-17 Mar 1989. In *U.S. Department of Energy thermal energy storage research activities review: 1989 Proceedings.* 357p. Order Number DE95016394. Source: OSTI; NTIS; GPO Dep.

Previous work by the author entailed modeling of the Packed Bed Thermal Energy Storage System, utilizing Phase-Change Materials, and a performance evaluation of the system based on the Second Law of thermodynamics. A principal conclusion reached is that the use of a single family of phase-change storage material may not in fact produce a thermodynamically superior system relative to one utilizing sensible heat storage material. This prompted us to modify our model so that we could investigate whether or not a significantly improved performance may be achieved via the use of multiple families of phase-change materials instead. Other factors investigated in the present work include the effect on system performance due to the thermal mass of the containment vessel wall, varying temperature and mass flow rate of the flue gas entering the packed bed during the storage process, and thermal radiation which could be a significant factor at high temperature levels. The resulting model is intended to serve as an integral part of a real-time simulation of the application of a high temperature regenerator in a periodic brick plant. This paper describes the more comprehensive model of the high temperature thermal energy storage system and presents results indicating that improved system performance could be achieved via a judicious choice of multiple families of phase-change materials.

29804 (CONF-890351–, pp. 217-237) **Complex-compound low-temperature TES system.** Rockenfeller, U. (Rocky Research, Boulder City, NV (United States)). USDOE Assistant Secretary for Conservation and Renewable Energy, Washington, DC (United

States). Office of Energy Management; Pacific Northwest Lab., Richland, WA (United States); Oak Ridge National Lab., TN (United States). Mar 1989. From Thermal energy storage program review; New Orleans, LA (United States); 15-17 Mar 1989. In *U.S. Department of Energy thermal energy storage research activities review: 1989 Proceedings*. 357p. Order Number DE95016394. Source: OSTI; NTIS; GPO Dep.

Development of a complex-compound low-temperature TES system is described herein from basic chemical principles through current bench scale system development. Important application engineering issues and an economic outlook are addressed as well. The system described uses adsorption reactions between solid metal inorganic salts and ammonia refrigerant. It is the coordinative nature of these reactions that allows for storage of ammonia refrigerant within the solid salt crystals that function as a chemical compressor during on peak periods (substituting the mechanical compressor) and release ammonia during off peak periods while a mechanical vapor compression system provides the necessary reactor pressure and heat.

29805 (CONF-890351–, pp. 294-331) **Performance of a chill ATES system.** Midkiff, K.C. (Univ. of Alabama, Tuscaloosa, AL (United States)); Song, Y.K.; Schaetzle, W.J. USDOE Assistant Secretary for Conservation and Renewable Energy, Washington, DC (United States). Office of Energy Management; Pacific Northwest Lab., Richland, WA (United States); Oak Ridge National Lab., TN (United States). Mar 1989. From Thermal energy storage program review; New Orleans, LA (United States); 15-17 Mar 1989. In *U.S. Department of Energy thermal energy storage research activities review: 1989 Proceedings*. 357p. Order Number DE95016394. Source: OSTI; NTIS; GPO Dep.

An aquifer air-conditioning system has been installed to cool the Student Recreation Center on the University of Alabama Campus. This research program encompasses the monitoring of the operation of the aquifer system and provision of emplacements to the system. The monitoring includes establishing the instrumentation, acquiring data, and analyzing the results. The instrumentation allows the measurement of water flow rates and corresponding temperatures, electrical energy input, aquifer temperatures at nineteen monitoring wells, and aquifer levels at six monitoring wells. Recent acquifer performance data indicate that 76% of the chill energy stored was recovered for the period Oct/86 - Sep/87 and 70% for the period Oct/87 - Sep/88. This is a substantial improvement over recoveries of 38% for the 1985 season and 55% for 1986. The overall coefficient of performance was 5.4 for Oct/86 - Sep/87 and 4.6 for Oct/87 - Sep/88. THe system has supplied 100% of the cooling with only about one-half of the energy input required by a conventional system. Some of the increased recovery of chilled water is a result of modifying the production well operation to reduce the regional flow of water toward the northwest. All warm water is withdrawn form the southeast wells, chilled, and injected in northwest wells. The cold water then withdrawn from the cold wells is used for air-conditioning but not reinjected into the aquifer. Additional flow control is provided by pumping (and discarding) water out of a southeast well, although the complete results of this new strategy are as yet unclear.

29806 (CONF-890351–, pp. 332-347) **Field testing of a high-temperature aquifer thermal energy storage system.** Sterling, R.L. (Univ. of Minnesota, Minneapolis, MN (United States)); Hoyer, M.C. USDOE Assistant Secretary for Conservation and Renewable Energy, Washington, DC (United States). Office of Energy Management; Pacific Northwest Lab., Richland, WA (United States); Oak Ridge National Lab., TN (United States). Mar 1989. From Thermal energy storage program review; New Orleans, LA (United States); 15-17 Mar 1989. In *U.S. Department of Energy thermal energy storage research activities review: 1989 Proceedings*. 357p. Order Number DE95016394. Source: OSTI; NTIS; GPO Dep.

The University of Minnesota Aquifer Thermal Energy Storage (ATES) System has been operated as a field test facility for the past six years. Four short-term and two long-term cycles have been completed to data providing a greatly increased understanding of the efficiency and geochemical effects of high-temperature aquifer thermal energy storage. A third long-term cycle is currently being planned to operate the ATES system in conjunction with a real heating load and to further study the geochemical impact on the aquifer from heated waste storage cycles. The most critical activities in the preparation for the next cycle have proved to be the applications for the various permits and variances necessary to conduct the third cycle and the matching of the characteristics of the ATES system during heat recovery with a suitable adjacent building thermal load.

29807 (KRC–90D-J03) **A Research and Development on Cold Storage Air Conditioning System.** Choi, H.S. (Korea Electric Power Corp. (KEPCO), Taejon (Korea, Republic of). Research Center); Lim, J.J.; Kim, Y.D.; Moon, K.S.; Hwang, S.D.; Choi, B.Y.; Yoo, S.I.; Kim, Y.D.; Yoo, A.K.; Song, H.Y.; Kim, S.H.; Kim, K.H.; Wan, J.J.; Hogn, J.S.; Kwak, H.T.;.Korea Electric Power Corp. (KEPCO), Taejon (Korea, Republic of). Research Center. 1994. 364p. (In Korean). Order Number DE96703581. Source: OSTI; NTIS (US Sales Only).

1. Object and Necessity of the study A. Necessity of the Study (1) Transition of nationwide energy consumption pattern (2) Unbalanced demand-supply of electricity due to increased comfort building energy (3) Continuation of electricity demand for the comfort air conditioning expected (4) Necessity of adequate cool storage system for Korean environment B. Object of the Study (1) Field testing of selected existing cool storage air conditioning site and establishing a performance test code (2) Development and test of 'Warm-ice' for cold storage and its thermal properties (3) Construction and demonstrate a new cool storage system (4) Economy analysis, suggestions for strategy for electricity supply department 2. Contents and Scope of the Study (1) Establish a database of cool storage system (2) Field test for selected existing cool storage air conditioning site, assessment, and economy analysis (3) Development of 'Warm-ice' for cold storage (4) Construction and demonstrate a new-concept cool storage system (30-50RTh) (5) Establish a performance Test Code for cool storage system (6) Suggestions for strategy for electricity supply department.

2508 Chemical

Refer also to citation(s) 29189, 29807

2509 Batteries

Refer also to citation(s) 29193, 30118

29808 (BNL–60541) **Effect of Ce composition on the structural and electronic characteristics of some metal hydride electrodes: A XANES and EXAFS investigation.** Mukerjee, S. (Brookhaven National Lab., Upton, NY (United States)); McBreen, J.; Reilly, J.J.; Johnson, J.R.; Adzic, G.; Kumar, M.P.S.; Zhang, W.; Srinivasan, S. Brookhaven National Lab., Upton, NY (United States). [1994]. 12p. Sponsored by USDOE, Washington, DC (United States). DOE Contract AC02-76CH00016. (CONF-941063–14: 186. meeting of the Electrochemical Society, Miami, FL (United States), 9-14 Oct 1994). Order Number DE96000426. Source: OSTI; NTIS; GPO Dep.

Substitution of the B component in the prototype AB_5 type ($LaNi_5$) metal hydride alloys have resulted in their increased acceptance as anodes for rechargeable alkaline batteries. Recently substitution of the A component (La) for imparting properties such as increased corrosion resistance has received attention. This investigation deals with the role of Ce as a substituent for the La and its effect in terms of corrosion resistance. The alloys chosen have the general composition of $La_xCe_{1-x}B_5$ (x = 1, 0.8, 0.5 and 0.25) where B is $Ni_{3.55}Co_{0.75}Mn_{0.4}Al_{0.3}$ together with alloys containing the mischmetal (Mm) as the A component (both synthetic and commercial). Electrochemical cycling results show that Ce lowers the capacity loss in the alloys and that this effect is not a simple function of the extent of lattice expansion during hydriding as was previously suggested. Correlation of the electrochemical and XAS results show that capacity loss is directly related to the extent of Ni corrosion. Effect of Ce substitution seems to result in a stable Ce oxide hydroxide coating which imparts the corrosion resistance.

29809 (ETDE/CH-mf–95787322) **Paul Scherrer Institut annual report 1994. Annex V: PSI general energy technology**

newsletter 1994. Daum, C.; Leuenberger, J. (eds.). Paul Scherrer Inst. (PSI), Villigen (Switzerland). 1995. 123p. Order Number DE95787322. Source: OSTI; NTIS.

This 1994 annual report of the General Energy Research Department of PSI presents 24 papers in the field of energy and process technology and 6 papers in the field of environmental research and system analysis. figs., tabs., refs.

29810 (ETDE/CH-mf–95787322, pp. 13-15) **Self discharge of the nickel oxide electrode.** Michaelis, R. (Paul Scherrer Inst. (PSI), Villigen (Switzerland)); Schnyder, B.; Koetz, R. Paul Scherrer Inst. (PSI), Villigen (Switzerland). 1995. In *Paul Scherrer Institut annual report 1994. Annex V: PSI general energy technology newsletter 1994.* 123p. Source: OSTI; NTIS.

For the optimization of the nickel/metal hydride battery the self discharge of the positive nickel hydroxide/oxide electrode (NOE) was investigated. Model electrodes were prepared by electrochemical impregnation according to the Kandler process. Electrodes of this type as well as industrial pasted nickel foam electrodes were cycled in 6 M KOH, and the capacity loss was measured at open circuit. The thickness of the nickel hydroxide film, the temperature and the composition of the NOE and the electrolyte were studied as parameters influencing the self discharge. (author) 4 figs., 6 refs.

29811 (ETDE/CH-mf–95787322, pp. 16-17) **Development and cycle test of zinc-oxygen cells.** Mueller, S. (Paul Scherrer Inst. (PSI), Villigen (Switzerland)); Holzer, F.; Haas, O. Paul Scherrer Inst. (PSI), Villigen (Switzerland). 1995. In *Paul Scherrer Institut annual report 1994. Annex V: PSI general energy technology newsletter 1994.* 123p. Source: OSTI; NTIS.

For the development of a rechargeable zinc/air battery, $La_{0.6}Ca_{0.4}CoO_3$-catalyzed (perovskite) bifunctional oxygen electrodes and pasted zinc electrodes were prepared and tested in monopolar zinc/air cells. The cells were cycled in moderately alkaline electrolyte. The maximum power as well as the cycle life of the cells were investigated. Up to 450 cycles could be reached, and attractive specific energies and powers were obtained. (author) 3 figs., 4 refs.

29812 (ETDE/CH-mf–95787322, pp. 18-19) **Insertion electrodes for lithium batteries.** Novak, P. (Paul Scherrer Inst. (PSI), Villigen (Switzerland)); Scheifele, W.; Joho, F.; Spahr, M.; Haas, O.; Nesper, R. Paul Scherrer Inst. (PSI), Villigen (Switzerland). 1995. In *Paul Scherrer Institut annual report 1994. Annex V: PSI general energy technology newsletter 1994.* 123p. Source: OSTI; NTIS.

Electrochemical insertion of Li^+, Na^+, and Mg^{2+} into various oxides, $MeV_3O_8(H_2O)$, (Me = Li,Na,K,$Ca_{0.5}$, and $Mg_{0.5}$), $Cu_{0.2}V_2O_5(H_2O)_y$, V_2O_5-xerogel, MoO_3, and V_6O_{13} (stoichiometric and non-stoichiometric), has been studied with regard to their use as electroactive materials of up to ≈300 mAh/g, ≈200 mAh/g, and ≈150 mAh/g were typically obtained in dry electrolytes for the Li^+, Na^+, and Mg^{2+} insertion, respectively. Except for MoO_3 and V_6O_{13}, the electroactive materials contain bound lattice water which is essential for good electrochemical performance of the oxides. For V_6O_{13} the specific charge remains fairly stable during cycling whereas for the other oxides the other oxides the specific charge does decrease to some extent. (author) 3 figs., 3 refs.

29813 (LBL–36782) **Surface modification of nickel battery electrodes by cobalt plasma immersion ion implantation and deposition.** Anders, S.; Anders, A.; Brown, I.; Kong, F.; McLarnon, F. Lawrence Berkeley Lab., CA (United States). Feb 1995. 17p. Sponsored by Electric Power Research Inst., Palo Alto, CA (United States);USDOE, Washington, DC (United States). DOE Contract AC03-76SF00098. EPRI Award 8042-03. (CONF-9502122–1: 2. international workshop in plasma-based ion implantation, Sydney (Australia), 12-15 Feb 1995). Order Number DE96001111. Source: OSTI; NTIS; GPO Dep.

Nickel hydroxide is the electrochemically active material in the positive electrode of several important rechargeable alkaline-electrolyte batteries. It is believed that divalent $Ni(OH)_2$ is converted to trivalent NiOOH as the electrode is electrochemically oxidized during the battery charging process, and the reverse reaction (electrochemical reduction) occurs during battery discharge, however the details of this process are not completely understood. Because these electrochemical reactions involve surface charge-transfer processes, it is anticipated that surface modification may result in improved battery performance. We used broad-beam metal ion implantation and Metal Plasma Immersion Ion Implantation and Deposition to add cobalt and other species to the nickel electrode surface. The principle of the latter technique is explained in detail. It is shown that implanted and deposited cobalt ions act as a dopant of $Ni(OH)_2$, and thereby alter its electronic conductivity. This electronic effect promotes lateral growth of NiOOH nodules and more-complete conversion of $Ni(OH)_2$ to NiOOH, which can be interpreted in terms of the nodule growth model. Other dopants such as Au, W, Pb, Ta and Ti_4O_7 were also tested for suppressing the parasitic oxygen evolution reaction in rechargeable nickel cells.

29814 (UCRL-JC–120314) **Lithium intercalation in porous carbon electrodes.** Tran, T.D. (and others); Feikert, J.; Pekala, R.W. Lawrence Livermore National Lab., CA (United States). Apr 1995. 9p. Sponsored by USDOE, Washington, DC (United States). DOE Contract W-7405-ENG-48. (CONF-950412–53: Spring meeting of the Materials Research Society (MRS), San Francisco, CA (United States), 17-21 Apr 1995). Order Number DE95017815. Source: OSTI; NTIS; GPO Dep.

Carbons derived from the phase separation of polyacrylonitrile/solvent mixtures were investigated as lithium intercalation anodes for rechargeable lithium-ion batteries. The carbon electrodes have a bulk density of 0.35-0.5 g/cm^3, relatively low surface areas (< 10 m^2/g), and micron-size cells. Pyrolysis temperature influences the reversible lithium intercalation and the irreversible capacity (associated with the formation of the passivating layer). Carbon electrodes pyrolyzed at 600°C have first-cycle capacity as high as 550 mAh/g as well as large irreversible capacity, 440 mAh/g. Electrodes prepared at 1050°C have reversible capacities around 270 mAh/g with relatively lower capacity losses (120 mAh/g). Doping the organic precursors with phosphoric acid, prior to pyrolysis at 1050°C, leads to carbon electrodes with reversible capacities as high as 450 mAh/g. The capacity of doped carbon increased with increasing phosphorus concentration in the samples. The doped carbon anodes exhibited good cycleability and excellent coulombic efficiency. The electrochemical performance is related to morphology, chemical composition, and local structural order.

29 ENERGY PLANNING AND POLICY

29815 (DOE/EIA–0202(95/3Q)) **Short-term energy outlook. Quarterly projections, Third quarter 1995.** USDOE Energy Information Administration, Washington, DC (United States). Office of Energy Markets and End Use. 2 Aug 1995. 46p. Sponsored by USDOE, Washington, DC (United States). Order Number DE95016192. Source: OSTI; NTIS; GPO; GPO Dep.

The Energy Information Administration (EIA) prepares quarterly, short-term energy supply, demand, and price projections for publication in February, May, August, and November in the Short-Term Energy Outlook (Outlook). An annual supplement analyzes the performance of previous forecasts, compares recent projections with those of other forecasting services, and discusses current topics related to the short-term energy markets. The forecast period for this issue of the Outlook extends from the third quarter of 1995 through the fourth quarter of 1996. Values for the second quarter of 1995, however, are preliminary EIA estimates.

29816 (DOE/EIA–0569(95/2Q)) **EIA directory of electronic products. Second quarter 1995.** National Energy Information Center, Washington, DC (United States). 4 Oct 1995. 76p. Sponsored by USDOE, Washington, DC (United States). Order Number DE96001050. Source: OSTI; NTIS; GPO Dep.

The Energy Information Administration (EIA) makes available for public use a series of machine-readable data files and computer models. They are available to the public on magnetic tapes; selected data files/models are available on diskette for IBM-compatible personal computers. This directory first presents the on-line files and compact discs. This is followed by descriptions and technical contacts and ordering and other information on the data files and models. An index by energy source is included. Additional ordering information is in the preface. The data files cover

petroleum, natural gas, electricity, coal, integrated statistics, and consumption; the models cover petroleum, natural gas, electricity, coal, nuclear, and multifuel.

29817 (ETDE/JP-mf–96704398) **Green helmet business (1993).** New Energy and Industrial Technology Development Organization, Tokyo (Japan). Dec 1994. 201p. (In Japanese). Sponsored by New Energy and Industrial Technology Development Organization, Tokyo (Japan). Order Number DE96704398. Source: OSTI; NTIS; Available from New Energy and Industrial Technology Development Organization, Sunshine 60, 30F 1-1, 3-chome, Higashi-Ikebukuro, Toshima-ku, Tokyo, Japan.

Commissioned by NEDO, research and investigation were conducted about effective transfer of energy-saving technology by the dispatch of experts. For propelling forward energy-saving in developing countries in Asia, it is stated that the endeavor will turn out to be quite effective when it is targeted at industries that consume quantities of energy and that the transfer mainly of software technology and its propagation are important. It is also stated that technology transfer processes in civil sector businesses rely for success on investigations prior to transfer, training in Japan of leaders of the technology receiving businesses, improvement on environments in the factory, establishment of basic operating technique, establishment of production control techniques, and establishment of management control techniques, and that a business that enjoys a smooth transfer of technology is a business wherein organization management system has been established and the employees of the receiving company assume leadership in the management of the organization. In China, with its steel and cement manufacturing businesses provided with facilities most of which are outdated, need is great for the adoption of energy-saving techniques for improved efficiency. Japan-based enterprises in China and Indonesia are of the opinion that transfer of business managing technology will not be easy. 51 figs., 32 tabs.

2901 Energy Analysis and Modeling

29818 (NEDO-P–9408) **Econometric analysis of alternative energies for oil.** New Energy and Industrial Technology Development Organization, Tokyo (Japan). Mar 1995. 291p. (In Japanese). Order Number DE96704387. Source: OSTI; NTIS; Available from New Energy and Industrial Technology Development Organization, Sunshine 60, 30F 1-1, 3-chome, Higashi-Ikebukuro, Toshima-ku, Tokyo, Japan.

A survey/analysis was made of energy policies, global environmental policies, positioning of oil substitution energy, and the feasibilities of main countries. At the same time, energy flow models in the world were constructed, and through various simulations, a quantitative analysis/evaluation was carried out on the world energy supply/demand and its effect on Japan in the case of carrying out various policies like the environmental tax. A possibility was sought for well solution to the global warming issue, agreement between the North-South countries, and solution to the resource issue such as possible depletion of fossil fuel. The result indicates that judging from the global warming, the resource, and the North-South problems, a target the world can maintain is 10 billion people in population, $200 trillion in GDP, and CO2 emission of 10 billion tons in 2100. The target may be achieved only if population control by income distribution, appropriate burden of the carbon tax, and energy-saving by technology transfer are introduced. 29 refs., 64 figs., 107 tabs.

2902 Economics and Sociology

Refer also to citation(s) 29837, 29869, 29884, 29914, 29917, 30286, 30567, 31405, 31412

29819 (DOE/EIA-TR–0599) **State energy severance taxes, 1985-1993.** USDOE Energy Information Administration, Washington, DC (United States). Sep 1995. 20p. Sponsored by USDOE, Washington, DC (United States). Order Number DE96000803. Source: OSTI; NTIS; INIS; GPO; GPO Dep.

This report analyzes changes in aggregate and State-level energy severance taxes for 1985 through 1993. Data are presented for crude oil, natural gas, and coal. The report highlights trends in severance tax receipts relative to energy prices and production, using severance tax data published by the Bureau of the Census of the US Department of Commerce and production data published by the Energy Information Administration.

29820 (DOE/ER/76005–T1) **Women in engineering program advocates network (WEPAN): Evaluation of the fourth annual conference.** Brainard, S.G. Washington Univ., Seattle, WA (United States). Aug 1994. 15p. Sponsored by USDOE, Washington, DC (United States). DOE Contract FG06-94ER76005. Order Number DE96000299. Source: OSTI; NTIS; GPO Dep.

The 1994 WEPAN conference highlighted the establishment of the three Regional Centers for Women in Engineering, which are located at the University of Washington, Purdue University, and Stevens Insitute of Technology. An overall evaluation was conducted on the effectiveness of the conference, including the quality of plenary sessions, workshops, registration, accommodations and reception.

29821 (DOE/ER/79198–T1) **SKILL PREP Program for American Indian Students. Final report, 1994.** McCulloh, S.; Huebner, P. South Dakota School of Mines and Technology, Rapid City, SD (United States). [1995]. 13p. Sponsored by USDOE, Washington, DC (United States). DOE Contract FG06-93ER79198. Order Number DE96000288. Source: OSTI; NTIS; GPO Dep.

The Scientific Knowledge for Indian Learning and Leadership (SKILL) precollege college program of the South Dakota School of Mines and Technology concluded the 1994 PREP program on July 22, 1994. The program graduated 22 students from the 4-week residential math/science program for American Indian students. Primary academic focus was physics (30 hours); each student was given a bicycle to solve problems on angular momentum and mechanical advantage. Mathematical calculations and problem solving exercises were done in mathematics class (20 hours). Preliminary results in math, physics, and geology show dramatic increases in student achievement over the 4- week period. The program paired every two students with a faculty member or research scientist, and each team completed a research project.

29822 (LA-SUB–95-143-PT.1) **New Mexicans' images and perceptions of Los Alamos National Laboratory. Winter, 1992–1993.** Los Alamos National Lab., NM (United States); New Mexico Univ., Albuquerque, NM (United States). Inst. for Public Policy. Jan 1993. 100p. Sponsored by USDOE, Washington, DC (United States). DOE Contract W-7405-ENG-36. Order Number DE96000863. Source: OSTI; NTIS; GPO Dep.

This report uses survey data to profile New Mexico residents' images and perceptions of Los Alamos National Laboratory (LANL). The survey results are the responses of a representative, stratified random sample of 992 New Mexico households to a set of questions asked in October, 1992. The data allow statistical inference to the general population's responses to the same set of questions at the time the survey was administered. The results provide an overview of New Mexico residents' current images and perceptions of the Laboratory. The sample margin of error is plus or minus 3.5% at the 95% confidence level.

29823 (LA-SUB–95-143-Pt.2) **New Mexicans' perceptions of Los Alamos National Laboratory: Awareness and evaluations.** Los Alamos National Lab., NM (United States); New Mexico Univ., Albuquerque, NM (United States). Inst. for Public Policy. Nov 1990. 40p. Sponsored by USDOE, Washington, DC (United States). DOE Contract W-7405-ENG-36. Order Number DE96000298. Source: OSTI; NTIS; GPO Dep.

This report uses survey data to profile New Mexico residents'perceptions of Los Alamos National Laboratory (LANL). The survey results are the responses of a representative, randomly selected sample of New Mexico households to a set of questions asked in September and October 1990. The data allow statistical inference to the general population's responses to the same set of questions at the time the survey was administered. The results provide an overview of New Mexico residents' current perceptions of LANL. The sample margin of error is slightly less than plus or minus five percent. Because our sample frame is designed to be proportionate to population, counties with the smallest populations, such as Mora and Los Alamos, tend to have very few respondents

in a standard sample. In order to have sample sizes sufficiently large to discern statistically significant differences across these counties, we took additional, non-proportionate random samples from Los Alamos County and its neighboring counties, including Rio Arriba, Taos, San Miguel, Mora and Sandoval Counties. This required the specification of new sample frames for each of the six counties and an additional sample of 300 respondents (50 in each county). Therefore, the analysis for this report is somewhat more complex than usual in that two separate samples will be analyzed, the state-wide random sample and the oversample.

29824 (NEDO-IT–9309) **Investigations concerning Japan's industrial technology related policies for the future aiming at enhanced international cooperation.** New Energy and Industrial Technology Development Organization, Tokyo (Japan). Mar 1994. 101p. (In Japanese). Order Number DE96704384. Source: OSTI; NTIS; Available from New Energy and Industrial Technology Development Organization, Sunshine 60, 30F 1-1, 3-chome, Higashi-Ikebukuro, Toshima-ku, Tokyo, Japan.

Consideration was made to study how Japan is to evolve its industrial technology related policies to enhance its cooperation with other countries. In the U.S. these days, for improving the capability of its domestic industries in competing in the international market, there is, in addition to its conventional trade policy, surfacing an opinion advocating a strategically managed trade in which the international trade policy will be more strongly tied with other policies regarding industry, technology, education and training, etc. Under the circumstances, it is up to Japan's technological renovation system to abandon the catch-up type for a frontier type and to construct a new system proper to Japan. Basic research is a vague concept and it is generally believed that every country should participate freely in international competition rather than produce rules common to the countries concerned. It has to be noted, however, that the conventional targeted type policy cannot successfully meet abrupt environmental changes and that there is no assurance that this type of policy will turn out to be a success. When the question of spillover of technology is taken up, it may be said that local support and accumulation of advanced technology may constitute an industrial policy at the beginning. Next, however, an important task will have to be dealt with, as to what cultural impact the spillover of technology will impose on the receiving side. 3 figs., 3 tabs.

29825 (WZB-FS-III–94-102) **The political construction of the nuclear energy issue and its impact on the mobilization of anti-nuclear movements in Western Europe.** Veroeffentlichungsreihe der Abteilung Oeffentlichkeit und Soziale Bewegung des Forschungsschwerpunkts Sozialer Wandel, Institutionen und Vermittlungsprozesse des Wissenschaftszentrums Berlin fuer Sozialforschung. Koopmans, R.; Duyvendak, J.W. Wissenschaftszentrum Berlin fuer Sozialforschung gGmbH (WZB) (Germany). Abt. Oeffentlichkeit und Soziale Bewegung. Nov 1994. 32p. (In German). Order Number DE96706576. Source: OSTI; NTIS (US Sales Only); INIS.

This paper investigates the relation between objective conditions and grievances on the one hand, and the construction of the nuclear energy 'problem' and the mobilization of anti-nuclear movements in Western Europe, on the other. Using data on protest reactions to the Chernobyl disaster in Germany, France, the Netherlands, and Switzerland, we first discuss the effects of so-called 'suddenly imposed grievances'. We then turn to the frame alignment model, which emphasizes the importance of processes of definition and interpretation for the mobilization of social movements, and confront this model with data on public attitudes towards nuclear energy and anti-nuclear movement mobilization in Western Europe. Our analysis indicates that objective conditions as such have little explanatory power, and that similar events and conditions have led to widely diverging interpretations and levels of anti-nuclear mobilization in different countries. We find that the differential success of the interpretative efforts of anti-nuclear movements does neither depend on the nature of the discursive struggle itself, nor on the evidential base for the anti-nuclear movement's claims. Our data show that the movements' political opportunities, and the resulting cross-national variations in the degree to which anti-nuclear movements have been able to block or slow down the expansion of nuclear energy, have been crucial determinants both of the movements' impacts on public opinion, and of the movements' levels of mobilization. We therefore conclude that a combination of the political opportunity and framing perspectives is most fruitful in making sense of the differential careers of the nuclear energy conflict in Western Europe. (orig.)

2903 Environment, Health, and Safety

Refer also to citation(s) 28790, 28792, 28794, 28807, 29014, 29039, 29040, 29041, 29061, 29077, 29080, 29153, 29447, 29791, 29854, 29927, 30682, 30771, 31408

29826 (BNL–61934) **Photovoltaic energy impacts on US CO_2 emissions.** Morris, S.C.; Lee, J.; Moskowitz, P.D.; Goldstein, G. Brookhaven National Lab., Upton, NY (United States). [1995]. 9p. Sponsored by USDOE, Washington, DC (United States). DOE Contract AC02-76CH00016. (CONF-9506112–1: Environmental Protection Agency (EPA) symposium on greenhouse gas emissions and mitigation research, Washington, DC (United States), 27-29 Jun 1995). Order Number DE95016031. Source: OSTI; NTIS; GPO Dep.

The potential role of photovoltaic (PV) technology in reducing CO_2 emissions was evaluated in an energy-environmental economic systems model. The model examines the role of photovoltaic energy systems in a competitive market environment. PV technology is already competitive for certain niche markets. Further growth in those markets is expected as well as expansion into other markets. Decreasing cost penalties should provide greater incentive for expansion of niche markets. This analysis indicated that, while PV was not projected to be competitive as a general source of electricity supply to the grid by 2030, it did become an attractive technology for this purpose after 2010 under carbon constraint, even if the carbon constraint was limited to stability of emissions at the 1990 level.

29827 (DOE/EA–0821) **Environmental Assessment for the Operation of the Glass Melter Thermal Treatment Unit at the US Department of Energy's Mound Plant, Miamisburg, Ohio.** USDOE, Washington, DC (United States). Jun 1995. 100p. Sponsored by USDOE, Washington, DC (United States). Order Number DE96000278. Source: OSTI; NTIS; INIS; GPO Dep.

The glass melter would thermally treat mixed waste (hazardous waste contaminated with radioactive constituents largely tritium, Pu-238, and/or Th-230) that was generated at the Mound Plant and is now in storage, by stabilizing the waste in glass blocks. Depending on the radiation level of the waste, the glass melter may operate for 1 to 6 years. Two onsite alternatives and seven offsite alternatives were considered. This environmental assessment indicates that the proposed action does not constitute a major Federal action significantly affecting the human environment according to NEPA, and therefore the finding of no significant impact is made, obviating the need for an environmental impact statement.

29828 (DOE/EA–0985) **Environmental Assessment: Relocation and storage of TRIGA® reactor fuel, Hanford Site, Richland, Washington.** USDOE Richland Operations Office, WA (United States). Aug 1995. 50p. Sponsored by USDOE, Washington, DC (United States). Order Number DE96000279. Source: OSTI; NTIS; INIS; GPO Dep.

In order to allow the shutdown of the Hanford 308 Building in the 300 Area, it is proposed to relocate fuel assemblies (101 irradiated, three unirradiated) from the Mark I TRIGA Reactor storage pool. The irradiated fuel assemblies would be stored in casks in the Interim Storage Area in the Hanford 400 Area; the three unirradiated ones would be transferred to another TRIGA reactor. The relocation is not expected to change the offsite exposure from all Hanford Site 300 and 400 Area operations.

29829 (DOE/EA–1022) **Environmental Assessment for the construction and operation of the Health Physics Site Support Facility on the Savannah River Site.** USDOE Savannah River Operations Office, Aiken, SC (United States). Jul 1995. 14p. Sponsored by USDOE, Washington, DC (United States). Order Number DE96000280. Source: OSTI; NTIS; INIS; GPO Dep.

DOE has prepared an environmental assessment for the proposed construction and operation of the Health Physics Site Support Facility on the Savannah River Site. This (new) facility would meet requirements of the site radiological protection program and would ensure site compliance with regulations. It was determined that the proposed action is not a major Federal action significantly affecting the quality of the environment within the meaning of NEPA. Therefore, a finding of no significant impact is made, and no environmental impact statement is needed.

29830 (DOE/EA–1053) **Environmental Assessment for decontaminating and decommissioning the General Atomics Hot Cell Facility. Final [report].** USDOE, Washington, DC (United States). Aug 1995. 55p. Sponsored by USDOE, Washington, DC (United States). Order Number DE96000277. Source: OSTI; NTIS; INIS; GPO Dep.

This EA evaluates the proposed action to decontaminate and decommission GA's hot cell facility in northern San Diego, CA. This facility has been used for DOE and commercial nuclear R&D for > 30 years. About 30,000 cubic feet of decontamination debris and up to 50,000 cubic feet of contaminated soil are to be removed. Low-level radioactive waste would be shipped for disposal. It was determined that the proposal does not constitute a major federal action significantly affecting the human environment according to NEPA; therefore, a finding of no significant impact is made, and an environmental impact statement is not required.

29831 (DOE/EA–1076) **Environmental Assessment for the proposed modification and continued operation of the DIII-D facility.** USDOE San Francisco Operations Office, Oakland, CA (United States). Jul 1995. 60p. Sponsored by USDOE, Washington, DC (United States). Order Number DE96000276. Source: OSTI; NTIS; INIS; GPO Dep.

The EA evaluates the proposed action of modifying the DIII-D fusion facility and conducting related research activities at the GA San Diego site over 1995-1999 under DOE contract number DE-ACO3-89ER51114. The proposed action is need to advance magnetic fusion research for future generation fusion devices such as ITER and TPX. It was determined that the proposed action is not a major action significantly affecting the quality of the human environment according to NEPA; therefore a finding of no significant impact is made and an environmental impact statement is not required.

29832 (DOE/EH–231-006/0991) **RCRA contingency plans and emergency procedures.** USDOE Assistant Secretary for Environment, Safety, and Health, Washington, DC (United States). Office of Environmental Guidance. Sep 1991. 2p. Sponsored by USDOE, Washington, DC (United States). Order Number DE96001049. Source: OSTI; NTIS; GPO Dep.

RCRA requires that owners and operators of hazardous waste treatment, storage, and disposal facilities develop and implement contingency plans defining effective actions to minimize unanticipated damage from any treatment, storage, or disposal of any hazardous waste. The plan sets out an organized, planned, and coordinated course of action to be followed to minimize hazards to human health or the environment from fires, explosions, or unplanned sudden or non-sudden releases of hazardous waste or hazardous waste constituents. Contingency plans must be prepared and implemented by owners and operators of interim status and permitted hazardous waste treatment, storage, and disposal facilities.

29833 (DOE/EH–231-014/0794) **RCRA facility assessments.** USDOE Assistant Secretary for Environment, Safety, and Health, Washington, DC (United States). Office of Environmental Guidance. Jul 1994. 2p. Sponsored by USDOE, Washington, DC (United States). Order Number DE96000974. Source: OSTI; NTIS; GPO Dep.

The Hazardous and Solid Waste Amendments of 1984 (HSWA) broadened the authorities of the Resource Conservation and Recovery Act (RCRA) by requiring corrective action for releases of hazardous wastes and hazardous constituents at treatment, storage, and disposal (TSD) facilities. The goal of the corrective action process is to ensure the remediation of hazardous waste and hazardous constituent releases associated with TSD facilities. Under Section 3004(u) of RCRA, operating permits issued to TSD facilities must address corrective actions for all releases of hazardous waste and hazardous constituents from any solid waste management unit (SWMU) regardless of when the waste was placed in such unit. Under RCRA Section 3008(h), the Environmental Protection Agency (EPA) may issue administrative orders to compel corrective action at facilities authorized to operate under RCRA Section 3005(e) (i.e., interim status facilities). The process of implementing the Corrective Action program involves the following, in order of implementation; (1) RCRA Facility Assessment (RFA); (2) RCRA Facility Investigation (RFI); (3) the Corrective Measures Study (CMS); and (4) Corrective Measures Implementation (CMI). The RFA serves to identify and evaluate SWMUs with respect to releases of hazardous wastes and hazardous constituents, and to eliminate from further consideration SWMUs that do not pose a threat to human health or the environment. This Information Brief will discuss issues concerning the RFA process.

29834 (DOE/EH–231-041/0794) **RCRA corrective action: Statement of basis and response to comments decision documents.** USDOE Assistant Secretary for Environment, Safety, and Health, Washington, DC (United States). Office of Environmental Guidance. Jul 1994. 4p. Sponsored by USDOE, Washington, DC (United States). Order Number DE96000988. Source: OSTI; NTIS; GPO Dep.

Under the Resource Conservation and Recovery Act (RCRA), Statement of Basis (SB) and Response to Comments (RTC) decision documents are prepared when a corrective action is implemented through either a permit or enforcement order [RCRA § 3008(h)]. EPA's Guidance on RCRA Corrective Action Decision Documents presents a standard format for documenting RCRA corrective action decisions. The guidance clarifies the roles and responsibilities of regulatory agencies in developing and issuing decision documents. DOE, for some corrective actions, may be directed to prepare materials for the Statement of Basis. EPA's guidance is intended to provide consistency in the organization and content of decision documents as well as promote clear and logical presentations of rationales for remedy selection decisions based on facility-specific information and supporting analysis. This Information Brief summarizes EPA's guidance on SB and RTC decision documents.

29835 (DOE/EH–413052) **RCRA corrective action for underground storage tanks – Subtitle C for Subtitle I.** USDOE Assistant Secretary for Environment, Safety, and Health, Washington, DC (United States). RCRA/CERCLA Div. Aug 1995. 30p. Sponsored by USDOE, Washington, DC (United States). Order Number DE95017757. Source: OSTI; NTIS; INIS; GPO Dep.

The purpose of this report is to provide guidance to DOE and DOE contractor personnel responsible for planning and implementation of corrective measures addressing cleanup of releases of hazardous materials or regulated substances from underground storage tanks regulated under RCRA Subtitle C or Subtitle I.

29836 (DOE/EH–96000397) **Environmental Guidance Regulatory Bulletin.** USDOE Assistant Secretary for Environment, Safety, and Health, Washington, DC (United States). RCRA/CERCLA Div. 31 Jul 1995. 6p. Sponsored by USDOE, Washington, DC (United States). Order Number DE96000397. Source: OSTI; NTIS; INIS; GPO Dep.

On September 15, 1994, EPA promulgated a Final Rule revising 40 CFR Part 300: the National Oil and Hazardous Substances Pollution Contingency Plan (NCP). NCP establishes a national response system for responding to discharges of oil and releases of hazardous substances. Figures illustrate the roles of the national response system. Response operations, planning and preparation, and designation of federal trustees are discussed, followed by definitions.

29837 (DOE/EIA–0598) **Electricity generation and environmental externalities: Case studies, September 1995.** USDOE Energy Information Administration, Washington, DC (United States). Office of Coal, Nuclear, Electric and Alternate Fuels. 28 Sep 1995. 98p. Sponsored by USDOE, Washington, DC (United States). Order Number DE96000696. Source: OSTI; NTIS; GPO; GPO Dep.

Electricity constitutes a critical input in sustaining the Nation's economic growth and development and the well-being of its inhabitants. However, there are byproducts of electricity production that have an undesirable effect on the environment. Most of these are emissions introduced by the combustion of fossil fuels, which accounts for nearly 70 percent of the total electricity generated in the United States. The environmental impacts (or damages) caused by these emissions are labeled environmental "externalities." Included in the generic term "externality" are benefits or costs resulting as an unintended byproduct of an economic activity that accrue to someone other than the parties involved in the activity. This report provides an overview of the economic foundation of externalities, the Federal and State regulatory approaches, and case studies of the impacts of the externality policies adopted by three States.

29838 (DOE/EIS–0210-Exec.Summ.) **Final Environmental Impact Statement: Executive summary.** Environmental Protection Agency, Atlanta, GA (United States). Region IV. Jun 1995. 40p. Sponsored by USDOE, Washington, DC (United States);Environmental Protection Agency, Washington, DC (United States);Department of the Army, Washington, DC (United States). (EPA–904/9-94-002(c)). Order Number DE96000273. Source: OSTI; NTIS; GPO Dep.

Tampa Electric Co. proposes to double its electric generating capacity by constructing a 1,150-MW power station in SW Polk county, Florida. It would consist of two combined cycle generating units,six combustion turbine generating units, and one integrated gasification combined cycle generating unit (IGCC). The IGCC unit would be capable of firing either coal-derived gas (syngas) produced by on-site coal gasification (CG) or low-sulfur fuel oil. The project would include on-site material handling and storage facilities for fuel oil, coal, and byproducts of CG and syngas treatment (slag, sulfuric acid); water supply and wastewater treatment systems; solid waste disposal areas; a cooling reservoir; a substation, and storm water management facilities. Transmission lines and pipeline facilities would also be included. This EIS document assesses the proposed project and alternatives with respect to environmental impacts. Mitigative measures are also evaluated for the preferred alternative.

29839 (DOE/EM–0256) **Fiscal Year 1994 progress in implementing Section 120 of the Comprehensive Environmental Rresponse, Compensation, and Liability Act. Eighth annual report to Congress.** USDOE Assistant Secretary for Environmental Restoration and Waste Management, Washington, DC (United States). Jul 1995. 120p. Sponsored by USDOE, Washington, DC (United States). Order Number DE95017758. Source: OSTI; NTIS; INIS; GPO Dep.

Congress passed the Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA) (Public Law 96-510), commonly known as Superfund, in 1980. The Superfund Amendments and Reauthorization Act (SARA) (Public Law 99-499), which amended CERCLA in 1986, added Section 120 regarding the cleanup of contaminated sites at Federal facilities. Under Section 120(e)(5) of CERCLA, each department, agency, or instrumentality of the Federal government responsible for compliance with Section 120 must submit an annual report to Congress concerning its progress in implementing the requirements of Section 120. The report must include information on the progress in reaching Interagency Agreements (IAGs), conducting Remedial Investigation and Feasibility Studies (RI/FSs), and performing remedial actions. Federal agencies that own or operate facilities on the National Priorities List (NPL) are required to begin an RI/FS for these facilities within 6 months after being placed on the NPL. Remediation of these facilities is addressed in an IAG between the Federal agency, the U.S. Environmental Protection Agency (EPA), and in some instances the state within which the facility is located. This report, prepared by the U.S. Department of Energy's (DOE's) Office of Environmental Management, is being submitted to Congress in accordance with Section 120(e)(5) of CERCLA. It is DOE's Eighth Annual Report to Congress and provides information on DOE's progress in implementing CERCLA Section 120 in Fiscal Year 1994 (FY 94), i.e., from October 1, 1993, to September 30, 1994. In this report the words "site" and "facility" are used interchangeably.

29840 (DOE/OR/21400–T483) **Final report on the Vitro CRADA.** Oak Ridge National Lab., TN (United States). Feb 1994. 9p. Sponsored by USDOE, Washington, DC (United States). DOE Contract AC05-84OR21400. Order Number DE96000664. Source: OSTI; NTIS; INIS; GPO Dep.

ORNL and Vitro investigated the application of advanced Geographic Information System (GIS) technologies to site characterization and environmental remediation work. The six tasks were to do feasibility studies for integrating GIS tools with DBMS, graphics, and other packages to aid in environmental analyses, develop environmental and geographic data standards and guidelines including data structures/quality assurance practices/metadata, investigate environmental and remediation predictive modeling and their integration with GIS, study remote sensing techniques including Global Positioning Systems techniques, and investigate display enhancement techniques including 2D/3D visualization coupled with GIS data bases.

29841 (KCP–613-5658) **A comparison of ISO 14001 to other related environmental management systems and tools.** White, S.E.; Byron, D.F.; Livingston, B.L. Allied-Signal Aerospace Co., Kansas City, MO (United States). Kansas City Div. Aug 1995. 11p. Sponsored by USDOE, Washington, DC (United States). DOE Contract AC04-76DP00613. (CONF-9509221–1: Aerospace industries hazardous materials management, Cincinnati, OH (United States), 6 Sep 1995). Order Number DE95017313. Source: OSTI; NTIS; INIS; GPO Dep.

Efficient environmental management is of increasing priority for the industrial sector. The achievement of ISO 14001 certification will demonstrate that the environmental management system meets or exceeds industry standards since this standard will be the accepted international measure of environmental management. A review of published environmental management systems and tools was conducted to ensure all aspects of environmental management are covered in the establishment or formalization of an environmental management system. The objective of this effort is to compare the ISO 14001 standard with other environmental management systems and tools.

29842 (LA-UR–95-2677) **Prioritization methodology using hazard analysis results at Los Alamos National Laboratory.** Sasser, M.K. (Los Alamos National Lab., NM (United States)); Hall, M.; Stack, D.; Brooks, D.G. Los Alamos National Lab., NM (United States). [1995]. 20p. Sponsored by USDOE, Washington, DC (United States). DOE Contract W-7405-ENG-36. (CONF-9508169–2: Energy Facilities Contractors Operating Group, Prioritization Working Group & Prioritization Methodology Users Group prioritization methodology workshop, Idaho Falls, ID (United States), 22-23 Aug 1995). Order Number DE96000022. Source: OSTI; NTIS; GPO Dep.

Risk management activities, such as prioritizing risk-reducing projects, often are commissioned for facilities as special tasks supported by special task forces and conducted independently of other on-going risk assessment and risk management activities. Many DOE facilities have completed hazard analyses (HAs) as part of their efforts to upgrade their SARs to meet the new DOE standard that was issued in 1994. Although a complete SAR would contain more resource allocation information than the HA, the HA usually is completed before the SAR. This paper describes how SAR results, and particularly HA results, can be used directly to support managers' risk-based prioritization of project funding. This can reduce the time to conduct prioritization modeling, increase the quality of the results, and, perhaps most importantly, integrate the results into the on-going risk management activities of the site.

29843 (LBL–35642) **Developing energy and environmental reporting protocols.** Schrock, D.W. (Pacific Northwest Lab., Richland, WA (United States)); Stoops, J.L.; Meier, A.K.; Vine, E.L.; Solomon, B.D. Lawrence Berkeley Lab., CA (United States). Aug 1994. 9p. Sponsored by USDOE, Washington, DC (United States). DOE Contract AC03-76SF00098. (CONF-9408169–9: American Council for Energy-Efficient Economy (ACEEE) summer conference, Asilomar, CA (United States), 28 Aug - 3 sep 1994). Order Number DE95016423. Source: OSTI; NTIS; GPO Dep.

In this paper, we concentrate on the reporting and verification of energy and emissions reductions rather than absolute levels. Absolute emissions levels are collected by the US Department of Energy's (US DOE) Energy Information Administration (EIA) and other agencies, using reporting and verification procedures that are straightforward and build upon previous data collection activities. In contrast, energy savings or reductions cannot be measured directly; instead they must be estimated by subtracting the final energy use from initial energy use. In the meantime, conditions may change, such as economic activity or weather, so that a simple subtraction may yield misleading results. Therefore, estimation, verification, and reporting of energy and emissions savings require considerably more information to ensure that the reductions are due to efficiency improvements rather changes in other conditions. The treatment of this additional information is a major challenge in efforts to report and tabulate energy savings in a consistent manner. This paper identifies several problem areas in reporting programs and some of the mechanisms for dealing with them.

29844 (NEDO-P--9402) **Investigation on the heat island phenomenon.** New Energy and Industrial Technology Development Organization, Tokyo (Japan). Mar 1995. 229p. (In Japanese). Order Number DE96704385. Source: OSTI; NTIS; Available from New Energy and Industrial Technology Development Organization, Sunshine 60, 30F 1-1, 3-chome, Higashi-Ikebukuro, Toshima-ku, Tokyo, Japan.

Through various researches into the phenomena to plan the measures against the heat island phenomenon, their influence on the urban environment was investigated together with the legislation for their control. In the large urban zone, the largest difference in atmospheric temperature is even 10°C between its central area and suburban area. In the past, the average atmospheric temperature through year rose by 2 to 3°C in the urban area during 100 years. It was mainly caused by the increase in artificial waste heat and fall in green coverage ratio due to the concentric consumption of energy in the urban area. The matter with anxiety is its influence on the ecological system, and social system which includes the atmospheric pollution and increase in air cooling power demand. As measures against it, importance consists in the decrease in artificial waste heat through the solar energy utilization, regional air cooling/heating and utilization of energy not utilized yet, and environmental urban planning through the widening of public parks and green tracts. In summer, the daytime rise in atmospheric temperature is not so remarkable as that of the night time. If it becomes, however, no longer negligible with the increase in artificial waste heat in the future, it will adversely circulate the increase in cooling power demand and increase in artificial waste heat. As environmental capital, not only the tree planting, but also the improvement in comprehensive heat environment must be planned, without delay, inclusively of the energy saving and storage. 144 refs., 21 figs., 24 tabs.

29845 (SAND--95-1648) **National Environmental Policy Act (NEPA) Compliance Guide, Sandia National Laboratories.** Hansen, R.P. (Hansen Environmental Consultants, Englewood, CO (United States)). Sandia National Labs., Albuquerque, NM (United States); Hansen Environmental Consultants, Englewood, CO (United States). Aug 1995. 247p. Sponsored by USDOE, Washington, DC (United States). DOE Contract AC04-94AL85000. Order Number DE95016765. Source: OSTI; NTIS; GPO Dep.

This report contains a comprehensive National Environmental Policy Act (NEPA) Compliance Guide for the Sandia National Laboratories. It is based on the Council on Environmental Quality (CEQ) NEPA regulations in 40 CFR Parts 1500 through 1508; the US Department of Energy (DOE) N-EPA implementing procedures in 10 CFR Part 102 1; DOE Order 5440.1E; the DOE "Secretarial Policy Statement on the National Environmental Policy Act" of June 1994-Sandia NEPA compliance procedures-, and other CEQ and DOE guidance. The Guide includes step-by-step procedures for preparation of Environmental Checklists/Action Descriptions Memoranda (ECL/ADMs), Environmental Assessments (EAs), and Environmental Impact Statements (EISs). It also includes sections on "Dealing With NEPA Documentation Problems" and "Special N-EPA Compliance Issues."

29846 (UCRL-JC--122110) **Middle Urals' pollution prevention priorities assessment project.** Gonzalez, M. (Lawrence Livermore National Lab., CA (United States)); Ott, R.L.; Chukanov, V. Lawrence Livermore National Lab., CA (United States). 13 Sep 1995. 5p. Sponsored by USDOE, Washington, DC (United States). DOE Contract W-7405-ENG-48. (CONF-9509225--1: Chemistry for protection of the environment, Lublin (Poland), 18-22 Sep 1995). Order Number DE96000396. Source: OSTI; NTIS; GPO Dep.

The Middle Urals is an important Russian industrial region. The key industries are also the most environmentally damaging: mining, metallurgical and chemical industries. There are some 600 large-sized and medium-sized enterprises located within the Middle Urals' region. Their annual solid and gaseous chemical releases have led to exceeding some maximum permissible contaminant concentrations by factors of tens and hundreds. The environmental problems of the Middle Urals are of such magnitude, seriousness, and urgency that the limited available resources can be applied only to the problems of the highest priority in the most cost-effective way. By the combined efforts of scientists from Lawrence Livermore National Laboratory (USA), Institute of Industrial Ecology (Ekaterinburg, Russia) and Russian Federal Nuclear Center (Snezhinsk, Russia) the project on Environmental Priorities Assessment was initiated in 1993. Because the project will cut across a spectrum of Russian environmental, social, and political issues, it has been established as a genuine Russian effort led by Russian principals. Russian participants are the prime movers and decision-makers, and LLNL participants are advisors. A preliminary project has been completed to gather relevant environmental data and to develop a formal proposal for the full priorities assessment project for submittal to the International Science and Technology Center. The proposed priorities assessment methodology will be described in this paper. The specific objectives of this project are to develop and to implement a methodology to establish Russian priorities for future pollution prevention efforts in a limited geographic region of the Middle Urals (a part of Chelyabinsk and Sverdlovsk Oblasts). This methodology will be developed on two geographic levels: local (town scale) and regional (region scale). Detailed environmental analysis will be performed on a local scale and extrapolated to the regional scale.

2904 Energy Resources

Refer also to citation(s) 30687

2905 Research, Development, Demonstration, and Commercialization

Refer also to citation(s) 28694, 28695, 28848, 29383, 29385, 29395, 29824, 29846, 30071, 30074, 30126, 30164, 30387, 30753, 31368, 31405, 31406

29847 (ANL--95/24) **Chemical Technology Division annual technical report, 1994.** Argonne National Lab., IL (United States). Jun 1995. 206p. Sponsored by USDOE, Washington, DC (United States). DOE Contract W-31109-ENG-38. Order Number DE96001020. Source: OSTI; NTIS; INIS; GPO Dep.

Highlights of the Chemical Technology (CMT) Division's activities during 1994 are presented. In this period, CMT conducted research and development in the following areas: (1) electrochemical technology, including advanced batteries and fuel cells; (2) technology for fluidized-bed combustion; (3) methods for treatment of hazardous waste and mixed hazardous/radioactive waste; (4) the reaction of nuclear waste glass and spent fuel under conditions expected for an unsaturated repository; (5) processes for separating and recovering transuranic elements from waste streams, concentrating radioactive waste streams with advanced evaporator technology, and producing ^{99}Mo from low-enriched uranium for medical applications; (6) electrometallurgical treatment of the many different types of spent nuclear fuel in storage at Department of Energy sites; and (8) physical chemistry of selected materials in environments simulating those of fission and fusion energy systems. The Division also conducts basic research in catalytic chemistry associated with molecular energy resources and novel ceramic precursors; materials chemistry of superconducting oxides,

electrified metal/solution interfaces, molecular sieve structures, and impurities in scrap copper and steel; and the geochemical processes involved in mineral/fluid interfaces and water-rock interactions occurring in active hydrothermal systems. In addition, the Analytical Chemistry Laboratory in CMT provides a broad range of analytical chemistry support services to the technical programs at Argonne National Laboratory (ANL).

29848 (CONF-9411140–Absts.) **Imaging sciences workshop.** Candy, J.V. Lawrence Livermore National Lab., CA (United States). 15 Nov 1994. 101p. Sponsored by USDOE, Washington, DC (United States). DOE Contract W-7405-ENG-48. From Imaging sciences workshop; Livermore, CA (United States); 15-16 Nov 1994. Order Number DE95017252. Source: OSTI; NTIS; GPO Dep.

This workshop on the Imaging Sciences sponsored by Lawrence Livermore National Laboratory contains short abstracts/articles submitted by speakers. The topic areas covered include the following: Astronomical Imaging; biomedical imaging; vision/image display; imaging hardware; imaging software; Acoustic/oceanic imaging; microwave/acoustic imaging; computed tomography; physical imaging; imaging algorithms. Selected papers are indexed separately for inclusion in the Energy Science and Technology Database.

29849 (DOE/AL/98816–T2) **Technology reinvestment project manufacturing education and training: Engineering education in manufacturing across the curriculum. Annual report, June 24, 1994–June 23, 1995.** Mulholland, G.; Powers, T.L. New Mexico State Univ., Las Cruces, NM (United States). 29 Sep 1995. 30p. Sponsored by USDOE, Washington, DC (United States);National Science Foundation, Washington, DC (United States);Department of Defense, Washington, DC (United States). DOE Contract FG04-94AL98816. Order Number DE96000307. Source: OSTI; NTIS; GPO Dep.

The goal of this project is to impart to engineering and business students, and to students from industry, the broad knowledge and practical skills to immediately help a manufacturing company become more competitive in any global economy while still providing a high quality work force for the 21st century. An integration of innovative, cross-disciplinary, manufacturing engineering and business education provided hand in hand with industry, will enable students, especially minority students, to have a real impact on manufacturing in this depressed region. The program was shortened and simplified to meet a budget of $2,000,000 versus the $3,000,000 in the-Proposal. All major objectives in the revised plan for the first year have been achieved with expenditures somewhat under the revised budget. Curriculum development with the advice and assistance of industry is ahead of schedule. Graduate minor degree curricula have been defined in Engineering and in Business. A summer intern project and guest lecture series have been well supported by industry. Facilities including advanced software have been brought on line. Cash and in-kind matching funds from industry, NMSU and the State total over $6m; this is 920% of the TRP funds expended. Cost sharing of cash is ahead of plan, of in-kind is slightly behind. The first group of 21 students have started one semester sooner than planned. The group is 25% minority and 45% female. Industry requests to interview graduates are coming in anticipation of availability in the spring of 1996.

29850 (ELFORSK–95-4) **Technology development in the energy sector. A review from Elforsk.** Haegermark, H. (comp.). Elforsk AB, Stockholm (Sweden). Jan 1995. 66p. (In Swedish). Order Number DE96703690. Source: OSTI; NTIS.

Swedish R,D and D in the energy sector since the first oil crisis are reviewed in this report. In all about 27,000 MSEK was spent, 60 percent by government and 40 percent by industry. In the report, brief accounts are given of the programs in the following areas: Biofuels and peat for power and heat generation; Wind power; Hydro power; Nuclear power; Fossil power; Novel power and heat generation; Efficient energy use; and Transmission and distribution of power. A list of operating swedish wind power plants is given in an appendix, together with a list of new biofueled cogeneration plants. 17 figs, 4 tabs

29851 (LA–12927-MS) **Technology transfer: Half-way houses. No. 17.** Seidel, R.W. Los Alamos National Lab., NM (United States). May 1995. 24p. Sponsored by USDOE, Washington, DC (United States). DOE Contract W-7405-ENG-36. Order Number DE95016383. Source: OSTI; NTIS; GPO Dep.

In the fall of 1993, 1 was asked by the Center for National Security Studies (CNSS) of the Los Alamos National Laboratory (LANL) to study the ways in which technology transfer and defense conversion had been accomplished at General Atomics (GA) and Science Applications International Corporation (SAIC) by interviewing Harold Agnew, who had served as director of Los Alamos before becoming president of General Atomics in 1979, and J. Robert Beyster, who had been a staff member at Los Alamos and at General Atomics before founding SAIC in 1969. Harold Agnew readily complied with my request for an interview and also suggested that I talk to Douglas Fouquet, who is in charge of public relations at General Atomics and is their unofficial historian. Robert Beyster was not available for an interview, but, through the courtesy of John C. Hopkins, a former director of CNSS, I was able to interview SAIC's executive vice president, Donald M. Kerr, who is also a former director at Los Alamos, and Steven Rockwood, a sector vice president at SAIC who was formerly a staff member at the Laboratory Because Agnew, Kerr, and Rockwood are all familiar with LANL, as well as with their respective companies, the interviews becam exercises In comparative analyses of technology transfer. In what follows, I have tried to summarize both the interviews and some of the research which attended them. It is the historian's hope that by use of comparative institutional analyses, Laboratory administrators may learn something of value in directing their efforts toward the transfer of technology to private industry and other government agencies.

29852 (LBL-PUB–3123-Rev.1) **Advanced light source, User's Handbook, Revision 1.** Lawrence Berkeley Lab., CA (United States). Jul 1995. 66p. Sponsored by USDOE, Washington, DC (United States). DOE Contract AC03-76SF00098. Order Number DE96000141. Source: OSTI; NTIS; GPO Dep.

The Advanced Light Source (ALS) is a national facility for scientific research and development located at the Lawrence Berkeley National Laboratory (LBNL) of the University of California. Its purpose is to generate beams of very bright light in the ultraviolet and soft x-ray regions of the spectrum. The facility is open to researchers from industry, universities, and government laboratories.

29853 (ORNL–6876) **Chemical and Analytical Sciences Division progress report for the period January 1, 1993–December 31, 1994.** Poutsma, M.L. Oak Ridge National Lab., TN (United States). Jun 1995. 159p. Sponsored by USDOE, Washington, DC (United States). DOE Contract AC05-84OR21400. Order Number DE96000900. Source: OSTI; NTIS; GPO Dep.

This report provides brief summaries of progress in the Chemical and Analytical Sciences Division (CASD) during 1993 and 1994. The first four chapters, which cover the research mission, are organized to mirror the major organizational units of the division and indicate the scope of the research portfolio. These divisions are the Analytical Spectroscopy Section, Nuclear and Radiochemistry Section, Organic Chemistry Section, and Physical and Materials Chemistry Section. The fifth and sixth chapters summarize the support activities within CASD that are critical for research progress. Finally, the appendices indicate the productivity and recognition of the staff in terms of various forms of external publications, professional activities, and awards.

29854 (ORNL/M–4227) **Integrated assessment briefs.** Oak Ridge National Lab., TN (United States). Apr 1995. 120p. Sponsored by USDOE, Washington, DC (United States). DOE Contract AC05-84OR21400. Order Number DE96000847. Source: OSTI; NTIS; GPO Dep.

Integrated assessment can be used to evaluate and clarify resource management policy options and outcomes for decision makers. The defining characteristics of integrated assessment are (1) focus on providing information and analysis that can be understood and used by decision makers rather than for merely advancing understanding and (2) its multidisciplinary approach, using methods, styles of study, and considerations from a broader variety of technical areas than would typically characterize studies produced from a single disciplinary standpoint. Integrated assessment may combine scientific, social, economic, health, and

environmental data and models. Integrated assessment requires bridging the gap between science and policy considerations. Because not everything can be valued using a single metric, such as a dollar value, the integrated assessment process also involves evaluating trade-offs among dissimilar attributes. Scientists at Oak Ridge National Laboratory (ORNL) recognized the importance and value of multidisciplinary approaches to solving environmental problems early on and have pioneered the development of tools and methods for integrated assessment over the past three decades. Major examples of ORNL's experience in the development of its capabilities for integrated assessment are given.

29855 (PNL–10700) **Chemical structure and dynamics. Annual report 1994.** Colson, S.D. Pacific Northwest Lab., Richland, WA (United States). Jul 1995. 70p. Sponsored by USDOE, Washington, DC (United States). DOE Contract AC06-76RL01830. Order Number DE96001344. Source: OSTI; NTIS; GPO Dep.

The Chemical Structure and Dynamics program was organized as a major component of Pacific Northwest Laboratory's Environmental and Molecular Sciences Laboratory (EMSL), a state-of-the-art collaborative facility for studies of chemical structure and dynamics. Our program responds to the need for a fundamental, molecular-level understanding of chemistry at the wide variety of environmentally important interfaces by (1) extending the experimental characterization and theoretical description of chemical reactions to encompass the effects of condensed media and interfaces, and (2) developing a multidisciplinary capability for describing interfacial chemical processes within which the new knowledge generated can be brought to bear on complex phenomena in environmental chemistry and in nuclear waste processing and storage. This research effort was initiated in 1989 and will continue to evolve over the next few years into a program of rigorous studies of fundamental molecular processes in model systems, such as well-characterized surfaces, single-component solutions, clusters, and biological molecules; and studies of complex systems found in the environment (multispecies, multiphase solutions; solid/liquid, liquid/liquid, and gas/surface interfaces; colloidal dispersions; ultrafine aerosols; and functioning biological systems). The success of this program will result in the achievement of a quantitative understanding of chemical reactions at interfaces, and more generally in condensed media, that is comparable to that currently available for gas-phase reactions. This understanding will form the basis for the development of a priori theories for predictions of macroscopic chemical behavior in condensed and heterogeneous media, adding significantly to the value of field-scale environmental models, the prediction of short- and long-term nuclear waste storage stabilities, and other problems related to the primary missions of the DOE.

29856 (SAND–94-3223) **High Consequence System Surety process description.** Randall, G.T. (comp.). Sandia National Labs., Albuquerque, NM (United States). Sep 1995. 26p. Sponsored by USDOE, Washington, DC (United States). DOE Contract AC04-94AL85000. Order Number DE95017836. Source: OSTI; NTIS; GPO Dep.

This report documents work-in-progress accomplished prior to programmatic changes that negated bringing this effort to conclusion as originally intended. The High Consequence System Surety (HCS^2) project pulls together a multi-disciplinary team to integrate the elements of surety safety, security, control, reliability and quality–into a new, encompassing process. The benefit of using this process is enhanced surety in the design of a high consequence system through an up-front, designed-in approach. This report describes the integrated, high consequence surety process and includes a hypothetical example to illustrate the process.

29857 (SAND–95-0338) **STDAC: Solar Thermal Design Assistance Center annual report fiscal year 1994.** Sandia National Labs., Albuquerque, NM (United States). [1994]. 41p. Sponsored by USDOE, Washington, DC (United States). DOE Contract AC04-94AL85000. Order Number DE95012524. Source: OSTI; NTIS; GPO Dep.

The Solar Thermal Design Assistance Center (STDAC) at Sandia is a resource provided by the DOE Solar Thermal Program. The STDAC's major objective is to accelerate the use of solar thermal systems by providing direct technical assistance to users in industry, government, and foreign countries; cooperating with industry to test, evaluate, and develop renewable energy systems and components; and educating public and private professionals, administrators, and decision makers. This FY94 report highlights the activities and accomplishments of the STDAC. In 1994, the STDAC continued to provide significant direct technical assistance to domestic and international organizations in industry, government, and education, Applying solar thermal technology to solve energy problems is a vital element of direct technical assistance. The STDAC provides information on the status of new, existing, and developing solar technologies; helps users screen applications; predicts the performance of components and systems; and incorporates the experience of Sandia's solar energy personnel and facilities to provide expert guidance. The STDAC directly enhances the US solar industry's ability to successfully bring improved systems to the marketplace. By collaborating with Sandia's Photovoltaic Design Assistance Center and the National Renewable Energy Laboratory the STDAC is able to offer each customer complete service in applying solar thermal technology. At the National Solar Thermal Test Facility the STDAC tests and evaluates new and innovative solar thermal technologies. Evaluations are conducted in dose cooperation with manufacturers, and the results are used to improve the product and/or quantify its performance characteristics. Manufacturers, in turn, benefit from the improved design, economic performance, and operation of their solar thermal technology. The STDAC provides cost sharing and in-kind service to manufacturers in the development and improvement of solar technology.

29858 (WSRC-MS–95-0300) **Savannah River Site Patented Technologies Summaries.** Rabold, D.E. Westinghouse Savannah River Co., Aiken, SC (United States). 18 Jul 1995. 75p. Sponsored by USDOE, Washington, DC (United States). DOE Contract AC09-89SR18035. Order Number DE96060015. Source: OSTI; NTIS; GPO Dep.

This information represents SRS's contribution of the DOE technology information network, an internet service coordinated out of Los Alamos. The information provided is strictly DOE-SR-titled and-issued patented technologies including environmental remediation, robotics, sensors, materials science, biomedical applications, hydrogen, and consumer products.

2906 Nuclear Energy

Refer also to citation(s) 29128, 29490, 29492

29859 (INIS-mf–14566) **Nuclear Power Development in Developing Countries.** Csik, B.J. (International Atomic Energy Agency, Vienna (Austria). Div. of Nuclear Power). International Atomic Energy Agency, Vienna (Austria). Div. of Public Information; Comision de Energia Atomica, La Habana (Cuba). 1995. 6p. (In Spanish). (CONF-9505292–: Regional seminar on public information of nuclear energy, Habana (Cuba), 17-19 May 1995). Order Number DE96602760. Source: OSTI; NTIS (US Sales Only); INIS.

The acceptance of nucleoenergetics by developing countries is explained in this paper.

29860 (INIS-mf–14568) **Public education on nuclear energy in high schools and universities in Cuba.** Pedrero Gonzalez, E. (Instituto Superior de Ciencia y Tecnologia Nuclear (ISCTN), La Habana (Cuba)). International Atomic Energy Agency, Vienna (Austria). Div. of Public Information; Comision de Energia Atomica, La Habana (Cuba). 1995. 6p. (In Spanish). (CONF-9505292–: Regional seminar on public information of nuclear energy, Habana (Cuba), 17-19 May 1995). Order Number DE96602761. Source: OSTI; NTIS (US Sales Only); INIS.

Efforts carried out by Cuba in public education regarding nuclear energy within the framework of the national school system are treated in this paper.

29861 (INIS-mf–14572) **Nuclear public information activities in Argentina.** Bustos, E. (Comision Nacional de Energia Atomica, Buenos Aires (Argentina)). International Atomic Energy Agency, Vienna (Austria). Div. of Public Information; Comision de Energia Atomica, La Habana (Cuba). 1995. 5p. (CONF-9505292–: Regional seminar on public information of nuclear energy, Habana (Cuba), 17-19 May 1995). Order Number DE96602763. Source: OSTI; NTIS (US Sales Only); INIS.

Public information activities related to Nuclear Energy in Argentina are dealt with in this paper from a journalist approach.

29862 (INIS-mf–14573) **Nuclear public information in Canada.** Macpherson, J.A. (Atomic Energy of Canada Ltd., Chalk River, ON (Canada). Chalk River Nuclear Labs.). International Atomic Energy Agency, Vienna (Austria). Div. of Public Information; Comision de Energia Atomica, La Habana (Cuba). 1995. 15p. (CONF-9505292–: Regional seminar on public information of nuclear energy, Habana (Cuba), 17-19 May 1995). Order Number DE96602764. Source: OSTI; NTIS (US Sales Only); INIS.

This paper describes some of the salient features of the Canadian experience in nuclear communications and examines three key aspects: opinion and attitude research; media relations; and education. It also addresses the challenge of responding to the allegations and tactics of those who are actively hostile to nuclear energy, and recommends that the principles of Total Quality Management and of organizational effectiveness be applied more thoroughly and more consistently to the communications function.

29863 (INIS-mf–14574) **The nuclear power programme in Cuba.** Serradet Acosta, M. (Ministerio de la Industria Basica, La Habana (Cuba)). International Atomic Energy Agency, Vienna (Austria). Div. of Public Information; Comision de Energia Atomica, La Habana (Cuba). 1995. 31p. (In Spanish). (CONF-9505292–: Regional seminar on public information of nuclear energy, Habana (Cuba), 17-19 May 1995). Order Number DE96602765. Source: OSTI; NTIS (US Sales Only); INIS.

This paper outlines the nuclear power programme in Cuba it also features current status of the programme and its prospects.

29864 (INIS-mf–14575) **Outline of public acceptance activities for nuclear energy in japan.** Kuroki, A. (International Atomic Energy Agency, Vienna (Austria). Div. of Public Information). International Atomic Energy Agency, Vienna (Austria). Div. of Public Information; Comision de Energia Atomica, La Habana (Cuba). 1995. 31p. (CONF-9505292–: Regional seminar on public information of nuclear energy, Habana (Cuba), 17-19 May 1995). Order Number DE96602766. Source: OSTI; NTIS (US Sales Only); INIS.

This paper provides an outline of public information activities related to nuclear matters in Japan.

29865 (NUREG–0936) **NRC regulatory agenda: Semiannual report, January–June 1995. Volume 14, Number 1.** Nuclear Regulatory Commission, Washington, DC (United States). Div. of Freedom of Information and Publications Services. Sep 1995. 50p. Sponsored by Nuclear Regulatory Commission, Washington, DC (United States). Source: OSTI; NTIS; INIS; GPO.

The Regulatory Agenda is a semiannual compilation of all rules on which the NRC has recently completed action, or has proposed action, or is considering action, and of all petitions for rulemaking that the NRC has received that are pending disposition. The agenda consists of two sections that have been updated through June 30, 1995. Section 1, "Rules," includes (A) rules on which final action has been taken since December 30, 1994, the closing date of the last NRC Regulatory Agenda; (B) rules published previously as proposed rules on which the Commission has not taken final action; (C) rules published as advance notices of proposed rulemaking for which neither a proposed nor final rule has been issued; and (D) unpublished rules on which the NRC expects to take action. Section 2, "Petitions for Rulemaking," includes (A) petitions denied or incorporated into final rules since December 30, 1994; (B) petitions incorporated into proposed rules; (C) petitions pending staff review, and (D) petitions with deferred action.

2907 Transport and Storage

29866 (CONF-890351–, pp. 1-17) **Thermal energy storage program description.** Reimers, E. (Dept. of Energy, Washington, DC (United States)). USDOE Assistant Secretary for Conservation and Renewable Energy, Washington, DC (United States). Office of Energy Management; Pacific Northwest Lab., Richland, WA (United States); Oak Ridge National Lab., TN (United States). Mar 1989. From Thermal energy storage program review; New Orleans, LA (United States); 15-17 Mar 1989. In *U.S. Department of Energy thermal energy storage research activities review: 1989 Proceedings.* 357p. Order Number DE95016394. Source: OSTI; NTIS; GPO Dep.

The U.S. Department of Energy (DOE) has sponsored applied research, development, and demonstration of technologies aimed at reducing energy consumption and encouraging replacement of premium fuels (notably oil) with renewable or abundant indigenous fuels. One of the technologies identified as being able to contribute to these goals is thermal energy storage (TES). Based on the potential for TES to contribute to the historic mission of the DOE and to address emerging energy issues related to the environment, a program to develop specific TES technologies for diurnal, industrial, and seasonal applications is underway. Currently, the program is directed toward three major application targets: (1) TES development for efficient off-peak building heating and cooling, (2) development of advanced TES building materials, and (3) TES development to reduce industrial energy consumption.

2910 Conservation

Refer also to citation(s) 29843, 29909

29867 (DOE/GO–10095-197) **What's new in federal energy management: Program overview.** National Renewable Energy Lab., Golden, CO (United States). Aug 1995. 2p. Sponsored by USDOE, Washington, DC (United States). DOE Contract AC36-83CH10093. Order Number DE95009282. Source: OSTI; NTIS; GPO Dep.

Each year, the Federal Government purchases an estimated $10–20 billion in energy-related products. As the world's largest customer, the Federal Government can greatly affect the availability and cost of products and technologies that save energy and conserve natural resources. The Energy Efficiency and Resource Conservation Challenge is a voluntary, government-wide commitment that uses the buying power of the Federal Government to support and expand markets for today's "best-practice," energy-efficient, renewable, and water-conserving products; create new entry markets for advanced, energy-saving technologies and products; lower the costs of efficient products for all consumers by providing a large, reliable market; reduce operating costs for Federal agencies, saving taxpayers' money; reduce Federal energy use and greenhouse gas emissions; provide a model for other levels of government, corporate, and institutional purchasers.

2920 Supply, Demand, and Forecasting

Refer also to citation(s) 28711, 28713, 29781, 29882

29868 (DOE/EIA–0204(95/03)) **Recently released EIA report presents international forecasting data.** USDOE Energy Information Administration, Washington, DC (United States). May 1995. 23p. Sponsored by USDOE, Washington, DC (United States). Order Number DE95016193. Source: OSTI; NTIS; GPO Dep.

This report presents information from the Energy Information Administration (EIA). Articles are included on international energy forecasting data, data on the use of home appliances, gasoline prices, household energy use, and EIA information products and dissemination avenues.

29869 (NEDO-P–9407) **Investigation on the actual situation of energy consumption in the commercial/residential.** New Energy and Industrial Technology Development Organization, Tokyo (Japan). Mar 1995. 260p. (In Japanese). Order Number DE96704386. Source: OSTI; NTIS; Available from New Energy and Industrial Technology Development Organization, Sunshine 60, 30F 1-1, 3-chome, Higashi-Ikebukuro, Toshima-ku, Tokyo, Japan.

To study the introduction of new energy and oil-alternative energy, and Japan's future energy supply and demand, investigation was made on the real situation of energy consumption in the commercial/residential sector of which the contribution ratio was high. Due to the development of service industry and rise in living level, the increasing ratio of energy demand is judged to be high also in future. Therefore, the possibility of introducing the new energy is highest in the commercial/residential sector. It is evident also from the morphological viewpoint of energy consumption. In fiscal 1994,

data were systematically put in order with existing research documents in the business department and domestic department. Then, the actual situation was surveyed through questionnaires to elucidate the structure and trend of consumption in those departments. From now on, the investigation correctly reflecting the real situation of energy consumption must be made with uninterrupted study by considering, the heightening of value added and diversification of service industry, progression of aged persons' society, change in life style and value judgment, female advance into the society, and trend of two-income family and young couple's family. 202 figs., 58 tabs.

29870 (NEDO-P–9434) **Field survey on energy policy information in the Pacific area. Electric power situation in Vietnam.** New Energy and Industrial Technology Development Organization, Tokyo (Japan). Mar 1995. 216p. (In Japanese). Order Number DE96704392. Source: OSTI; NTIS; Available from New Energy and Industrial Technology Development Organization, Sunshine 60, 30F 1-1, 3-chome, Higashi-Ikebukuro, Toshima-ku, Tokyo, Japan.

The paper makes field surveys and collects synthetic information on petroleum substitution energy mostly in the electric power field in Vietnam. The electric utility industry of Vietnam is within the control of the Ministry of Energy. It is managed by three power government corporations, two power investigation/design government corporations, four power construction government corporations, and one research institute. The overall generated output in all Vietnam as of the end of 1993 was 10,665.2 million kWh, each half of which was from the North and the South. The overall capacity of power facilities was 4,188 MW, the main part of which is the hydroelectric power, followed by the thermal power. The development of petroleum substitution energy in Vietnam is being made mostly in the hydroelectric power field, and the development of gas-thermal and coal-thermal powers is planning to be made at the same time. In Vietnam, energy efficiency is low and there is much room for energy conservation. To reduce transmission loss, it is planned to make distribution lines 20 kv and maintain/replace deteriorated distribution lines. Environmental protection measures have just started to be taken. Vietnam needs the international assistance. 17 refs., 58 figs., 37 tabs.

2930 Policy, Legislation, and Regulation

29871 (DOE/IG–0379) **Report on audit of Bonneville Power Administration's energy resource programs.** USDOE Bonneville Power Administration, Portland, OR (United States). 8 Sep 1995. 17p. Sponsored by USDOE, Washington, DC (United States). Source: OSTI (Free of Charge).

The Bonneville Power Administration (Bonneville) must ensure that the costs of its contracts for energy resources are as low as reasonably possible and that the resources are needed. During the audit, we reviewed Bonneville's energy resource programs and focused on its purchase of electrical output from natural gas fired combustion turbines. The objective of this audit was to determine if Bonneville paid excessive costs to acquire the electrical output from combustion turbine facilities. The audit showed that Bonneville contracted to purchase the output from a combustion turbine facility at excessive cost, and that the electricity was not needed. The cost of the electricity under this contract exceeded the amount of revenue Bonneville could obtain by selling it. Bonneville estimated it would operate the generation facility for only 6 months of the year; the contract, however, required Bonneville to pay the fixed costs of the facility during the other 6 months. Consequently, the cost of the electricity plus the fixed costs in the first year of the contract would exceed revenues by $20.9 million. The contract also contained cost escalators that exceeded the rate of inflation. These cost escalators combined with the excessive initial cost resulted in projected excessive costs of $146.8 million in the first 5 years of the contract, Finally, the contract was not needed due to competition from similar facilities and a desire by customers to diversify their sources of electricity.

29872 (NUREG–0980-Vol.1-No.3) **Nuclear Regulatory legislation: 103d Congress. Volume 1, No. 3.** Nuclear Regulatory Commission, Washington, DC (United States). Office of the General Counsel. Aug 1995. 532p. Sponsored by Nuclear Regulatory Commission, Washington, DC (United States). Source: OSTI; NTIS; INIS; GPO.

This document is a compilation of nuclear regulatory legislation and other relevant material through the 103d Congress, 2d Session. This compilation has been prepared for use as a resource document, which the NRC intends to update at the end of every Congress. The contents of NUREG-0980 include the Atomic Energy Act of 1954, as amended; Energy Reorganization Act of 1974, as amended, Uranium Mill Tailings Radiation Control Act of 1978; Low-Level Radioactive Waste Policy Act; Nuclear Waste Policy Act of 1982; and NRC Authorization and Appropriations Acts. Other materials included are statutes and treaties on export licensing, nuclear non-proliferation, and environmental protection.

29873 (NUREG–0980-Vol.2-No.3) **Nuclear Regulatory legislation: 103d Congress. Volume 2, No. 3.** Nuclear Regulatory Commission, Washington, DC (United States). Office of the General Counsel. Aug 1995. 457p. Sponsored by Nuclear Regulatory Commission, Washington, DC (United States). Source: OSTI; NTIS; INIS; GPO.

This document is a compilation of nuclear regulatory legislation and other relevant material through the 103d Congress, 2d Session. This compilation has been prepared for use as a resource document, which the NRC intends to update at the end of every Congress. The contents of NUREG-0980 include the Atomic Energy Act of 1954, as amended; Energy Reorganization Act of 1974, as amended, Uranium Mill Tailings Radiation Control Act of 1978; Low-Level Radioactive Waste Policy Act; Nuclear Waste Policy Act of 1982; and NRC Authorization and Appropriations Acts. Other materials included are statutes and treaties on export licensing, nuclear non-proliferation, and environmental protection.

2940 Fossil Fuels

Refer also to citation(s) 28711, 28748, 29837, 29867, 29868, 29878

29874 (DOE/EIA–0600) **Oil and gas development in the United States in the early 1990's: An expanded role for independent producers.** USDOE Energy Information Administration, Washington, DC (United States). Office of Energy Markets and End Use. Oct 1995. 28p. Sponsored by USDOE, Washington, DC (United States). Order Number DE96000764. Source: OSTI; NTIS; GPO; GPO Dep.

Since 1991, the major petroleum companies' foreign exploration and development expenditures have exceeded their US exploration and development expenditures. The increasing dependence of US oil and gas development on the typically much smaller nonmajor companies raises a number of issues. Did those companies gain increased prominence largely through the reduced commitments of the majors or have they been significantly adding to the US reserve base? What are the characteristics of surviving and growing producers compared with companies exiting the US oil and gas business? Differences between majors' development strategies and those of other US oil and gas producers appear considerable. As the mix of exploration and development strategies in US oil and gas increasingly reflects the decisions of smaller, typically more specialized producers, what consequences can be seen regarding the costs of adding to US reserves? How are capital markets accessed? Are US oil and gas investments by the nonmajors likely to be undertaken only with higher costs of capital? This report analyzes these issues. 20 figs., 6 tabs.

2960 Electric Power

Refer also to citation(s) 29335, 29338, 29781, 29837, 29867, 29870, 29878, 29879, 29956, 31408

29875 (CONF-950643–3) **Net lost revenue from DSM: State policies that work.** Baxter, L.W. Oak Ridge National Lab., TN (United States). [1995]. 14p. Sponsored by USDOE, Washington, DC (United States). DOE Contract AC05-84OR21400. From 7. national demand-side management conference: delivering customer value; Dallas, TX (United States); 28-30 Jun 1995. Order Number DE95014034. Source: OSTI; NTIS; GPO Dep.

A key utility regulatory reform undertaken since 1989 allows utilities to recover the lost revenue incurred through successful operation of demand-side management (DSM) programs. Net lost revenue adjustment (NLRA) mechanisms are states preferred approach to lost revenue recovery from DSM programs. This paper examines the experiences states and utilities are having with the NLRA approach. The paper has three objectives: (1) determine whether NLRA is a feasible and effective approach to the lost-revenue disincentive for utility DSM programs, (2) identify the conditions linked to effective implementation of NLRA mechanisms and assess whether NLRA has changed utility investment behavior, and (3) suggest improvements to NLRA mechanisms. Contrary to the concerns raised by some industry analysts, our results indicate NLRA is a feasible approach. Seven of the ten states we studied report no substantial problems with their approach. We observe several conditions linked to effective NLRA implementation. Observed changes in utility investment behavior occur after implementation of DSM rate reforms, which include deployment of NLRA mechanisms. Utilities in states with lost revenue recovery invest more than twice as much in DSM as do utilities in other states.

29876 (ELFORSK–95-16) **Scenarios for the future.** Haegermark, H.; Bergmark, M. Elforsk AB, Stockholm (Sweden). Jun 1995. 116p. (In Swedish). Order Number DE96703694. Source: OSTI; NTIS; INIS.

This project aims primarily to give a basis for the joint R and D program for the Swedish electric utility industry, in the form of pictures of the future up to 2020. The work was performed during four seminars in a group of managers and R and D planners. The four scenarios differ mainly in the assumptions of high or low economic growth and on market or political rule. Assumptions on essential uncertainties about the future have been combined in a consistent manner, e.g. on the structure of the utility industry, the role of nuclear power, the importance of the greenhouse gas issue, the influence of new technology developments and on changes of values in society. Certain other development appear in all scenarios, e.g. the impact of information technology throughout society, the internationalization of business in general and industrial production in particular, considerations for the environment and care for natural resources. The four scenarios are: 'Technology on the throne' (market rule/high growth); 'Intense competition' (market rule/low growth); 'Monopoly takes over' (political rule/high growth); and 'Green local society' (political rule/low growth). Some of the important factors pointed out by the study are: Increased customer mobility between regions and countries; The impact of information technology; Societal value changes; Sustainable development as an important driving force; Structure of the utility industry. Diversifying into new services. New players; Access to knowledge and competence; Ways for handling the greenhouse gas problem; Preparedness for nuclear power phase-out. 12 figs, 6 tabs

29877 (LBL–37157-Vol.2) **Evaluation of public service Electric & Gas Company's standard offer program: Volume II: Appendices.** Goldman, C.A.; Kito, M.S.; Moezzi, M.M. Lawrence Berkeley Lab., CA (United States). Jul 1995. 66p. Sponsored by USDOE, Washington, DC (United States). DOE Contract AC03-76SF00098. Order Number DE96001013. Source: OSTI; NTIS; GPO Dep.

This report presents interview protocol for PSE&G projects customers and sponsors.

2980 Consumption and Utilization

Refer also to citation(s) 29868, 29869

29878 (DOE/EIA–0204(95/04)) **EIA new releases, July–August, 1995.** USDOE Energy Information Administration, Washington, DC (United States). 2 Oct 1995. 23p. Sponsored by USDOE, Washington, DC (United States). Order Number DE96000765. Source: OSTI; NTIS; GPO; GPO Dep.

This publication identifies energy related publications of the Energy Information Administration of the US Department of Energy. The topics and articles in this issue include data on residential energy use available on diskettes and Internet, natural gas price predictions, coal deliveries to electric utilities, growth in the US uranium industry, microfiche products, features and press releases, EIA's electronic publishing system, new reports, machine-readable files, how to order EIA publications and energy data information contacts.

29879 (DOE/EIA–0226(95/09)) **Electric Power Monthly, September 1995: With data for June 1995.** USDOE Energy Information Administration, Washington, DC (United States). Office of Coal, Nuclear, Electric and Alternate Fuels. ©Sep 1995. 198p. Sponsored by USDOE, Washington, DC (United States). Order Number DE96000051. Source: OSTI; NTIS; GPO.

The Electric Power Monthly (EPM) presents monthly electricity statistics for a wide audience including Congress, Federal and State agencies, the electric utility industry, and the general public. The purpose of this publication is to provide energy decisionmakers with accurate and timely information that may be used in forming various perspectives on electric issues that lie ahead. The Coal and Electric Data and Renewables Division; Office of Coal, Nuclear, Electric and Alternate Fuels, Energy Information Administration (EIA), Department of Energy prepares the EPM. This publication provides monthly statistics at the State, Census division, and US levels for net generation, fossil fuel consumption and stocks, quantity and quality of fossil fuels, cost of fossil fuels, electricity sales, revenue, and average revenue per kilowatthour of electricity sold. Data on net generation, fuel consumption, fuel stocks, quantity and cost of fossil fuels are also displayed for the North American Electric Reliability Council (NERC) regions.

29880 (DOE/EIA–0321(93)) **Household energy consumption and expenditures 1993.** USDOE Energy Information Administration, Washington, DC (United States). Office of Energy Markets and End Use. 5 Oct 1995. 315p. Sponsored by USDOE, Washington, DC (United States). Order Number DE96001099. Source: OSTI; NTIS; GPO; GPO Dep.

This presents information about household end-use consumption of energy and expenditures for that energy. These data were collected in the 1993 Residential Energy Consumption Survey; more than 7,000 households were surveyed for information on their housing units, energy consumption and expenditures, stock of energy-consuming appliances, and energy-related behavior. The information represents all households nationwide (97 million). Key findings: National residential energy consumption was 10.0 quadrillion Btu in 1993, a 9% increase over 1990. Weather has a significant effect on energy consumption. Consumption of electricity for appliances is increasing. Houses that use electricity for space heating have lower overall energy expenditures than households that heat with other fuels. RECS collected data for the 4 most populous states: CA, FL, NY, TX.

29881 (PNL-SA–26326) **Estimating environmental benefits of energy programs.** Baechler, M.C.; Schrock, D.W. Pacific Northwest Lab., Richland, WA (United States). Jul 1995. 6p. Sponsored by USDOE, Washington, DC (United States). DOE Contract AC06-76RL01830. (CONF-950729–12: 30. Intersociety energy conversion conference, Orlando, FL (United States), 30 Jul - 5 aug 1995). Order Number DE95016810. Source: OSTI; NTIS; GPO Dep.

Three national reporting programs that either collect or report information on energy savings and the associated emissions reductions from DSM programs are the Conservation Verification Protocols (CVP), the Greenhouse Gas Voluntary Reporting Program (VRP), and the Green Lights Program. The CVP were enacted to report the atmospheric emissions reductions of $S0_2$ and $N0_2$. The VRP was mandated in the Energy Policy Act of 1992 (EPAct) Section 1605(b) to report CO_2, emissions reductions. Green Lights is a program designed to reduce emissions by encouraging energy-efficient lighting. In this paper we concentrate on how the verification methods, default emission factors and reporting mechanisms affect the accuracy of the reported energy and emissions savings. Additionally, we focus on the dynamic nature of predicted emissions reductions to gauge the accuracy of predictions over time. If conservation programs are designed to affect existing powerplants, if no load growth is anticipated, and if existing plants will not require replacement, a simple static analysis based on an existing resource mix may be acceptable. This approach is enhanced by defining base case, intermediate, and peak

resources. However, if today's decisions will affect tomorrow's resource decisions, or if the estimates will be used to establish important milestones (such as emission credits), it is prudent to conduct an analysis that captures most incumbent uncertainties. These uncertainties include future resource decisions and the regional character of energy resources, which may not be captured by national estimates and simple extrapolation techniques. While some estimation methods, such as use of default emission factors, produce reasonable national average numbers, the estimates may not be applicable to specific regions. The environmental and economic value of programs may be misstated.

2990 Unconventional Sources and Power Generation

Refer also to citation(s) 29385, 29818, 29867

29882 (NEDO-P–9409) **Investigation of actual state of minor scale power generation after deregulation in the U.S.** New Energy and Industrial Technology Development Organization, Tokyo (Japan). Mar 1995. 176p. (In Japanese). Order Number DE96704388. Source: OSTI; NTIS; Available from New Energy and Industrial Technology Development Organization, Sunshine 60, 30F 1-1, 3-chome, Higashi-Ikebukuro, Toshima-ku, Tokyo, Japan.

Investigations were conducted to learn the actual state of and prospective for enhanced new energy introduction and its future prospective in the U.S. Photovoltaic power generation is very expensive at the current stage. The solar cell industry has to go on to strive to lower the unit price of the module and to improve on its efficiency. Improved beam-condensing units and thin film making techniques will lower the cost. In the last twenty years there has been a remarkable advancement in wind power generation in terms of cost and reliability. Even now, however, difficulties involving sites for construction and coordination between systems related remain impedimental to the exploitation of wind resources in the middle and western parts of the U.S. Geothermal power generation in the U.S. is expected to grow on in the 1990s but the rate of development will be far lower than that in the 1980s. Impeding factors are that new power generating facilities are not needed and that there is doubt about the capability of geothermal power generation to effectively compete with the thermal power stations when they are reused. As for power generation utilizing biomass or municipal solid waste, it is not believed that there will be technological advancement leading to a remarkable reduction in the unit price of power to be generated by these means. 26 refs., 13 figs., 7 tabs.

29883 (NEDO-P–9460) **Interchanges with EU countries of researchers interested in petroleum substitution energy.** New Energy and Industrial Technology Development Organization, Tokyo (Japan). Mar 1995. 70p. (In Japanese). Order Number DE96704393. Source: OSTI; NTIS; Available from New Energy and Industrial Technology Development Organization, Sunshine 60, 30F 1-1, 3-chome, Higashi-Ikebukuro, Toshima-ku, Tokyo, Japan.

Information was exchanged with researchers participating in the development of petroleum substitution energy in the EU nations. Invited were Dr. Werner Wobbe and Mr. Michel Lamblin, experts belonging to the Commission of European Union. Dr. Wobbe says that Japan's industrial sector is quite advanced in adopting technology for enhancing energy efficiency; that the heat/electricity management specialist system is unexampled and is not seen in any other country; that on the contrary Japan is less advanced than North European countries in housing; and that probably there will be technological cooperation in the fields of the international clean energy system utilizing hydrogen, solar power generation, and fuel battery. Mr. Lamblin says that there is nothing to impede cooperation in the research phase in the field of refreshable energy, that therefore the JOULE program of the European Union and NEDO will be able to support some projects or technologies; that, for example, it is possible for JOULE and NEDO to appeal to industries concerned for PV; and that seminars may be organized for the propagation of energy related technologies.

29884 (NREL/CP–200-8098, pp. 1484-1493) **An assessment of the economic and employment impacts of the commercialization of renewable technologies in Washington/Oregon.** Roberts, P.A. (DynCorp Environmental, Alexandria, VA (United States)); Harrison, I.S.; Reinertsen, J.L. National Renewable Energy Lab., Golden, CO (United States). [1995]. (CONF-9508104–: 2. meeting on biomass of the Americas, Portland, OR (United States), 21-24 Aug 1995). In *Second biomass conference of the Americas: Energy, environment, agriculture, and industry. Proceedings.* 1741p. Order Number DE95009230. Source: OSTI.

DynCorp EENSP conducted an economic impact analysis for the National Renewable Energy Laboratory, under contract to the Department of Energy Office of Utility Technologies to explore the effects on the economy and employment by deploying renewable technologies. Two regions (Texas and Washington/Oregon) with abundant renewable resources were selected for their initial evaluation of the economy and employment. This analysis investigated changes in the level of employment, effects on various industries, and changes in economic activity by simulating the addition of renewable resources to the generation mix. An economic input-output model was used to predict future economic and employment changes that are driven by renewable energy deployment in selected regions. In Washington/Oregon, the construction, and operation and maintenance (O&M) for wind, biomass stoker, biomass IGCC, geothermal, combined cycle, and combustion turbine were modeled. In order to compare the relative benefits of renewable deployment, three technology adoption scenarios were also developed to allow for the broad comparison of the "expected" or currently planned resource additions to the region with scenarios that are more renewable intensive. The deployment scenarios chosen were: Business as Usual, Renewable Intensive, and Renewable Portfolio. The results indicate that installations of renewable technologies can have a positive impact on the state economy by creating primary and secondary employment benefits.

30 DIRECT ENERGY CONVERSION

3001 MHD Generators

29885 (DOE/ET/10815–T73) **Contract status report for MHD research and development and operation of the MHD Coal Fired Flow Facility for the month ending May 31, 1995.** Tennessee Univ., Tullahoma, TN (United States). Space Inst. [1995]. 7p. Sponsored by USDOE, Washington, DC (United States). DOE Contract AC02-79ET10815. Order Number DE95016640. Source: OSTI; NTIS; GPO Dep.

This report contains the operations schedule for the month of May 1995 at the University of Tennessee Space Institute's Coal Fired MHD Flow Facility.

29886 (DOE/ET/10815–T74) **Contract status report for MHD research and development and operation of the MHD Coal Fired Flow Facility for the month ending June 30, 1995.** Tennessee Univ., Tullahoma, TN (United States). Space Inst. [1995]. 7p. Sponsored by USDOE, Washington, DC (United States). DOE Contract AC02-79ET10815. Order Number DE95016688. Source: OSTI; NTIS; GPO Dep.

This report contains the operations schedule for the month of June 1995 at the University of Tennessee Space Institute's Coal Fired MHD Flow Facility.

3003 Thermoelectric Generators

Refer also to citation(s) 29487

3005 Fuel Cells

Refer also to citation(s) 29190, 29809

29887 (DOE/MC/28055–95/C0493) **Tubular solid oxide fuel cell commercialization program.** Forbes, C.A. Westinghouse Electric Corp., Pittsburgh, PA (United States). Science and Technology Center. [1995]. 3p. Sponsored by USDOE, Washington, DC (United States). DOE Contract FC21-91MC28055. (CONF-9505279–1: Fuel cell technology forum, Boston, MA (United

States), 16 May 1995). Order Number DE95015473. Source: OSTI; NTIS; GPO Dep.

Developing clean, efficient, and cost effective technologies for future power generation is essential to meeting the world's energy needs, while helping to clean up pollution and conserve valuable natural resources. Westinghouse is pioneering the development of solid oxide fuel cell (SOFC) technology as one of the promising technologies that will lead the world into a new generation of power production. The Westinghouse SOFC consists of tubular cells that can utilize fuels such as natural gas, coal derived fuel gas, biomass gas, and distillate fuels. Besides fuel flexibility, tubular SOFCs promise very high efficiencies, low cost, low plant maintenance, and ease of operation, and they have already demonstrated essentially no acid rain pollutants.

29888 (ETDE/CH-mf–95787322, pp. 20-22) **Microelectrode investigation of the oxygen permeation in different proton exchange membranes.** Buechi, F.N. (Paul Scherrer Inst. (PSI), Villigen (Switzerland)); Srinivasan, S. Paul Scherrer Inst. (PSI), Villigen (Switzerland). 1995. In *Paul Scherrer Institut annual report 1994. Annex V: PSI general energy technology newsletter 1994.* 123p. Source: OSTI; NTIS.

The oxygen solubility and diffusivity was measured by the microelectrode technique in various proton exchange membranes. The investigated parameters are relevant to the polymer electrolyte fuel technique, as the oxygen reduction reaction kinetics and the permeation of oxygen in the active layer of the electrodes are some of the limiting factors in these low-temperature fuel cells. In the different membrane materials the concentration of oxygen was increasing, and the diffusion coefficient was decreasing with increasing equivalent weight of the membranes. This behaviour may be explained by the two-phase model for the swollen membrane, in which the aqueous and the hydrophobic phase have different oxygen permeation properties. (author) 2 figs., 1 tab., 3 refs.

29889 (ETDE/CH-mf–95787322, pp. 23-26) **Scale-up of polymer electrolyte fuel cells.** Rota, M. (Paul Scherrer Inst. (PSI), Villigen (Switzerland)); Buechi, F.N.; Scherer, G.G. Paul Scherrer Inst. (PSI), Villigen (Switzerland). 1995. In *Paul Scherrer Institut annual report 1994. Annex V: PSI general energy technology newsletter 1994.* 123p. Source: OSTI; NTIS.

A new cell concept for a Polymer Electrolyte Fuel Cell (PEFC) stack was studied. This new design features internal manifolding, forced gas convection and may be used with active areas of up to 100 cm^2. Single cells were operated on hydrogen and air. The influence of gas pressure and air stoichiometry (λ) on power density was investigated for the new design using PSI membranes. When the gas pressure increases from 2 to 5 bar abs. the power density improves from 260 to 320 mW/cm^2 (T=60°C, λ=4.4, Pt loading 0.6 mg/cm^2). At a constant pressure of 4 bar, the air flow was varied between 3 and 6.5 l/min ($2.6<\lambda<5.7$), and the corresponding power densities were in the range of 270 to 340 mW/cm^2, respectively. (author) 6 figs., 1 tab., 7 refs.

29890 (KRC–90G-S03) **A Development of 40kW Phosphoric Acid Fuel Cell System.** Lee, C.W. (Korea Electric Power Corp. (KEPCO), Taejon (Korea, Republic of). Research Center); Ji, P.S.; Im, H.C.; Han, K.H.; Han, S.W.; Ahn, G.S.; Kim, K.B.; Park, P.Y.; Ahn, H.J.; Sul, J.H.; Nam, K.M.; Yang, K.S.; Kim, S.S.; Park, Y.S.; Kim, H.Y.; Chung,.Korea Electric Power Corp. (KEPCO), Taejon (Korea, Republic of). Research Center. 1994. 302p. (In Korean). Order Number DE96703588. Source: OSTI; NTIS (US Sales Only).

To establish the practizing technology of phosphoric acid fuel cell (PAFC) power generation system, KEPCO Research Center imported and installed 50kW PAFC package and then excuted the long term operation test of the 50kW PAFC system. This system recorded 6,000 hours of accumulative generating time and produced 184,190 kWH electricity by the end of 1994. At the rated power measured electrical efficiency was showed 37.46% and thermal efficiency 43.8%. The average electric capacity factor and output of this system showed 63.01% and 33.5kW for the entire operation period. In terms of system performance, after more than 5,000 hours of operation time, the voltage drop of 3.8mV/1,000 Hr was observed in this system. Also more than 23 times of package troubles were experienced by the end of 1994. The problems encountered during the operation is that the plant was too sensitive to changes in external condition. Throughout test operation, we confirmed that it will be needed to improve the life time of stack, operation reliability and reduce the capital costs and maintenance cost for practizing the PAFC system.(author). 26 refs., fig.

29891 (LA-SUB–93-134) **Continued study of the effects of heat treatment and microstructure on electrocatalyst performance. Final report, July 29, 1991–December 20, 1991.** Stoner, G.E. Los Alamos National Lab., NM (United States). Feb 1992. 4p. Sponsored by USDOE, Washington, DC (United States). DOE Contract W-7405-ENG-36. Order Number DE96000170. Source: OSTI; NTIS; GPO Dep.

Platinum and platinum-chromium bulk electrodes were analyzed in 100 wt.% H_3PO_4 at 200° C to evaluate the kinetics for the oxygen reduction reaction (ORR) in the phosphoric acid fuel cell (PAFC) operating environment. Dispersed platinum and platinum-chromium catalyst electrodes were operated potentiostatically under simulated PAFC operating conditions (0.7 V vs. RHE in 100 wt.% H_3PO_4 at 200° C) using the submerged mode to evaluate the degradation mechanism. Differences observed between the hanging meniscus rotating disk (HMRD) electrode and the rotating disk electrode (RDE) method were related to the different hydrodynamics present in the hanging meniscus. The boundary conditions applicable to an infinite rotating disk are no longer present. The most probable cause for the observed differences is that the surface of the HMRD electrode is no longer uniformly accessible with respect to the diffusing species. Therefore, the kinetic data extracted from the mixed control conditions are altered sufficiently so that precise potential-current curves cannot be obtained. However, the data obtained are highly reproducible. Therefore, the method appears suitable for determining comparative kinetic data for platinum and platinum-chromium at 200 a C in 100 wt.% H_3PO_4, where RDE designs will not function. Cyclic voltammetry conducted on platinum and platinum-chromium electrodes in 100 wt.% H_3PO_4 at 200° C were similar qualitatively to those obtained at room temperature. Comparison of the double layer currents demonstrated that an approximately two-fold increase in surface area, due to dissolution of chromium from the electrode surface, occurred during typical cycling durations; extensive chromium dissolution was observed during long-term cycling.

29892 (LA-UR–95-2484) **Through-the-electrode model of a proton exchange membrane fuel cell with independently measured parameters.** Weisbrod, K.R.; Grot, S.A.; Vandergborgh, N.E. Los Alamos National Lab., NM (United States). [1995]. 15p. Sponsored by USDOE, Washington, DC (United States). DOE Contract W-7405-ENG-36. (CONF-9510207–6: 1. international symposium on proton conducting membrane fuel cells, Chicago, IL (United States), 8-13 Oct 1995). Order Number DE95016994. Source: OSTI; NTIS; GPO Dep.

A one dimensional model for a proton exchange membrane fuel cell was developed which makes use of independently measured parameters for predicting single cell performance. Optimization of catalyst layer formulation and properties are explored. Impact of temperature and cathode pressure upon system performance is investigated.

29893 (NEDO-IT–9302) **Survey of recent researches into the production of chemicals by chemical cogeneration. 2.** New Energy and Industrial Technology Development Organization, Tokyo (Japan). Mar 1994. 142p. (In Japanese). Order Number DE96704376. Source: OSTI; NTIS; Available from New Energy and Industrial Technology Development Organization, Sunshine 60, 30F 1-1, 3-chome, Higashi-Ikebukuro, Toshima-ku, Tokyo, Japan.

A survey was undertaken about the recent development in the chemical cogeneration (CCG) method used for the simultaneous production of chemicals, electric power, and heat, with the fuel cell serving as the chemical reaction device. In the high temperature reaction system using a perovskite based solid electrolyte, a solid electrolyte capable of CCG reactions as a proton conductor has been obtained, which may be applied to dehydrogenizing reactions. It is possible to consider a CCG reaction system incorporating an oxidizing reaction for the supply of energy, yet an oxide ion conductor capable of lower temperature operations need be composed. In reaction systems using a zirconia based solid electrolyte, there is an oxide ion conductor applicable to CCG reaction

systems for oxidizing reactions, such as YSZ, whereinto several researches are already under way. In a low temperature reaction system, some solid electrolytes are available, such as organic naphion or inorganic materials impregnated with the water solution of phosphoric acid, and, in this connection, various reactions at the room temperature up to 200 degrees centigrade are the objects of investigations. 130 refs., 51 figs., 28 tabs.

3008 Miscellaneous Converters

29894 (NEDO-P–9424) **Investigation of power generation system using shape memory alloys.** New Energy and Industrial Technology Development Organization, Tokyo (Japan). Mar 1994. 99p. (In Japanese). Order Number DE96704389. Source: OSTI; NTIS; Available from New Energy and Industrial Technology Development Organization, Sunshine 60, 30F 1-1, 3-chome, Higashi-Ikebukuro, Toshima-ku, Tokyo, Japan.

Investigations were conducted for the embodiment of a power generation system using shape memory alloys (alloys), which concerned the study of a case wherein the subject system was annexed to a typical thermal engine and of the possibility of the subject system aiming at the effective use of energy remaining unused. Strength, repeated stress/distortion characteristics, fatigue and service life, and other dynamic properties were examined, for the selection of a TiNi based alloy equipped with O-phase transformation capability. A cascade system and energy saving/converting system, in which reciprocating engines using this metal are parallelly connected, were presented. Repetition of heating (<100 degrees centigrade) and cooling (approximately to room temperature) are required for the metal to function. For the supply of heat, four heat sources (geothermally heated water, refuse incineration waste heat, solar energy, heat from a gas turbine) were studied, and the power output recoverable for each heat engine was estimated. 43 refs., 82 figs., 9 tabs.

32 ENERGY CONSERVATION, CONSUMPTION, AND UTILIZATION

Refer also to citation(s) 29426, 29427

3201 Buildings

Refer also to citation(s) 28720, 28721, 28722, 28723, 28724, 28725, 28726, 28727, 28728, 28729, 28730, 29422, 29800, 29805, 29880, 29930, 30118, 30569, 30643, 30644

29895 (BNL–61860) **Development and technology transfer of the BNL flame quality indicator for oil-fired applications: Project report.** Butcher, T.A.; Litzke, Wai Lin; McDonald, R.J. Brookhaven National Lab., Upton, NY (United States). Sep 1994. 46p. Sponsored by USDOE, Washington, DC (United States). DOE Contract AC02-76CH00016. Order Number DE95013593. Source: OSTI; NTIS; GPO Dep.

The purpose of a flame quality indicator is to continuously and closely monitor the quality of the flame to determine a heating system's operating performance. The most efficient operation of a system is achieved under clean burning conditions at low excess air level. By adjusting a burner to function in such a manner, monitoring the unit to maintain these conditions can be accomplished with a simple, cheap and reliable device. This report details the development of the Flame Quality Indicator (FQI) at Brookhaven National Laboratory for residential oil-heating equipment. It includes information on the initial testing of the original design, field testing with other cooperating organizations, changes and improvements to the design, and finally technology transfer and commercialization activities geared towards the development of commercially available products designed for the oil heat marketplace. As a result of this work, a patent for the technology was obtained by the U.S. Department of Energy (DOE). Efforts to commercialize the technology have resulted in a high level of interest amongst industry members including boiler manufacturers, controls manufacturers, oil dealers, and service organizations. To date DOE has issued licenses to three different manufacturers, on a non-exclusive basis, to design, build, and sell FQIs.

29896 (CONF-890351–, pp. 97-123) **Development of PCM wallboard for heating and cooling of residential buildings.** Salyer, I.O. (Univ. of Dayton Research Institute, OH (United States)); Sircar, A.K. USDOE Assistant Secretary for Conservation and Renewable Energy, Washington, DC (United States). Office of Energy Management; Pacific Northwest Lab., Richland, WA (United States); Oak Ridge National Lab., TN (United States). Mar 1989. Contract 19X-SC-542V. From Thermal energy storage program review; New Orleans, LA (United States); 15-17 Mar 1989. In *U.S. Department of Energy thermal energy storage research activities review: 1989 Proceedings.* 357p. Order Number DE95016394. Source: OSTI; NTIS; GPO Dep.

The goals of this project were to find, test, and develop an effective phase change material (PCM) for heating and cooling of residential buildings. Specifications for the PCM included thermal storage of at least 30 cal/gm, congruent melting and freezing, at 25°C, nontoxic, noncorrosive, nonhygroscopic, low-cost, and commercially available in quantity. The PCM must be able to be incorporated into ordinary building materials (plasterboard, concrete, floor tile) by processes adaptable to commercial manufacture. The goals of the original program have been substantially achieved by identifying a series of linear crystalline alkyl hydrocarbon PCM that are commercially available from petroleum refining (lower cost, lower "purity"), and from polymerization of ethylene (higher cost, higher "purity"). Four alternate processes have been developed whereby these PCM can be incorporated into plasterboard and concrete building materials. Two of the processes have been successfully demonstrated in the laboratories of the two largest U.S. manufacturers of plasterboard, and collaborative development leading toward commercialization is still ongoing. Problem areas remaining to be resolved include: establishing unequivocably the economic viability of the system, developing environmentally acceptable fire retarding procedures, scale up of the manufacturing processes and evaluating effects of long-term thermocycling. We are scaling up the immersion process to include imbibing and testing 4-ft x 8-ft plasterboard panels. Successful completion is expected to encourage a plasterboard manufacturer to commercialize the technology. Five U.S. patents have been issuedand U.S. and foreign patents are pending. One foreign license has been negotiated. Spin-offs of the technology likely to be commercialized soon in the U.S. include tableware, hot and cold medical wraps, and wraps to prevent the overnight freezing of citrus tree trunks.

29897 (CONF-890351–, pp. 124-127) **Computer and graphics modeling of heat transfer and phase change in a wall with randomly imbibed PCM.** Solomon, A.D. USDOE Assistant Secretary for Conservation and Renewable Energy, Washington, DC (United States). Office of Energy Management; Pacific Northwest Lab., Richland, WA (United States); Oak Ridge National Lab., TN (United States). Mar 1989. From Thermal energy storage program review; New Orleans, LA (United States); 15-17 Mar 1989. In *U.S. Department of Energy thermal energy storage research activities review: 1989 Proceedings.* 357p. Order Number DE95016394. Source: OSTI; NTIS; GPO Dep.

We describe the theoretical basis and computer implementation of a simulation code for heat transfer and phase change in a rectangular 2-dimensional region in which PCM has been randomly placed with a preassigned volume fraction.

29898 (CONF-940893–19) **Energy efficiency capital requirements for buildings in the United States.** MacDonald, M. Oak Ridge National Lab., TN (United States). [1994]. 12p. Sponsored by USDOE, Washington, DC (United States). DOE Contract AC05-84OR21400. From Summer conference on energy efficiency in buildings; Monterey, CA (United States); 29 Aug - 3 sep 1994. Order Number DE95014031. Source: OSTI; NTIS; GPO Dep.

Estimates of energy savings for any national energy efficiency or environmental improvement program should be based on a reasonable understanding of how much of the market can be served by such a program and what is the total value of investment required (capital requirements) to accomplish the savings claimed by the program. Current information on the energy savings performance

and capital requirements of large-scale energy efficiency programs is used to develop a simple framework for analysis of capital requirements and the size of markets (dollar value of the markets) to compare with proposed new initiatives or programs. The comparison provides a reality check on the energy savings claimed. Based on this framework, current energy efficiency efforts and estimates of @p for proposed initiatives are examined. The examination shows that, in the United States, investment requirements for achieving claimed national energy savings goals should be estimated more consistently and that constraints related to the dollar volume of markets do not appear to be considered adequately. The analysis framework is used to show that major growth in costing energy efficiency markets is needed, and that simple reliance on existing approaches such as current utility DSM programs will not be adequate to reach proposed goals. Any nation serious about achieving needed energy use reductions in buildings should have reliable information about the costs of and increase in market size needed for achieving reduction goals. The analysis framework presented here will help improve that reliability.

29899 (CONF-950624–5) **Experimental analysis of a window air conditioner with a R-22 and R32/R125/R134a mixture.** Mei, V.C. (Oak Ridge National Lab., TN (United States)); Chen, F.C.; Chen, D.T.; HuangFu, E.P. Oak Ridge National Lab., TN (United States). [1995]. 15p. Sponsored by USDOE, Washington, DC (United States). DOE Contract AC05-84OR21400. From Annual meeting of the American Society of Heating, Refrigeration and Air-Conditioning Engineers, Inc. (ASHRAE); San Diego, CA (United States); 24-28 Jun 1995. Order Number DE95014251. Source: OSTI; NTIS; GPO Dep.

Much experimental and theoretical analysis of potential R-22 replacements has been accomplished. However, published information about the experimental analysis of any off-the-shelf air conditioner with a potential R-22 replacement at realistic, operating conditions is still rare. This type of work could be useful because it provides baseline data for comparing the performance of R-22 and its potential replacement at drop-in conditions. In this study, an off-the-shelf window air conditioner was tested at Air Conditioning and Refrigeration Institute (ARI)-rated indoor conditions and at different ambient temperatures, including the ARI-rated outdoor condition, with R-22 and with its potential replacement, a ternary mixture of R-32(30%)/R-125(10%)/R-134a(60%) (the ternary mixture). A test rig was built that provided for baseline operation and for the option of operating the system with a flooded evaporator by means of liquid over-feeding (LOF). The test results indicated the cooling capacity of the ternary mixture was 7.7% less than that of R-22 at 95°F ambient for baseline operation. The cooling capacity for both refrigerants improved when a flooded evaporator, or LOF, was used. For LOF operation, the cooling capacity of the ternary mixture was only 1.1% less than that of R-22. The ternary mixture had slightly higher compressor discharge pressure, a lower compressor discharge temperature, slightly lower compressor power consumption, and a higher compressor high/low pressure ratio.

29900 (CONF-951215–1) **The evaluation of retrofit measures in a tall residential building.** Abraham, M.M.; McLain, H.A. Oak Ridge National Lab., TN (United States). [1995]. 23p. Sponsored by USDOE, Washington, DC (United States). DOE Contract AC05-84OR21400. From 6. thermal performances of the exterior envelopes of buildings; Clearwater Beach, FL (United States); 4-8 Dec 1995. Order Number DE95014281. Source: OSTI; NTIS; GPO Dep.

As part of a joint demonstration effort involving the US Department of Energy (DOE), the US Department of Housing and Urban Development (HUD), Boston Edison Company (BECo), and the Chelsea Housing Authority, Oak Ridge National Laboratory (ORNL) participated in the evaluation of energy and demand saving retrofits for a tall residential building located in Boston. The thirteen story all-electric building underwent window, lighting, and control renovations in December, 1992. annual energy consumption was reduced by 15% and peak demand fell by 17%. Hourly should building consumption data were available for the comparison of pre- and post- conditions and for calibration of a DOE-2.1D simulation model. The analysis found the window retrofit accounted for 90% of total energy savings and 95% of average demand savings, due to reductions in both conduction and infiltration. Benefits from lighting retrofits were low in cooling months and negligible in winter months due to the increase in the demand for electric resistance heating which was proportional to the reduction in lighting capacity. Finally, the simulation model verified that heating system controls had not been used as intended, and that the utility rate structure would not allow cost savings from the original control strategy. These results and other interesting lessons learned are presented.

29901 (CONF-951215–2) **An ORNL office building used as a federal test bed for energy efficient roofs.** McLain, H.; Christian, J.E. Oak Ridge National Lab., TN (United States). [1995]. 40p. Sponsored by USDOE, Washington, DC (United States). DOE Contract AC05-84OR21400. From 6. thermal performances of the exterior envelopes of buildings; Clearwater Beach, FL (United States); 4-8 Dec 1995. Order Number DE95016349. Source: OSTI; NTIS; GPO Dep.

The energy savings benefits of re-covering the roof of an existing federal office building with a sprayed polyurethane foam system are documented. The building is a 12,880 ft^2 (1,197 m^2), 1 story, masonry structure located at the Oak Ridge National Laboratory (ORNL), Oak Ridge, TN. Prior to re-covering, the roof had a thin fiberglass insulation layer, which had become partially soaked because of water leakage through the failed built-up roof membrane. The average R-value for this roof measured at 2 $hr \cdot ft^2 \cdot °F/Btu$ (0.3 $m^2 \cdot K/W$). After re-covering the roof, it measured at 13 $hr \cdot ft^2 \cdot °F/Btu$ (2.3 $m^2 \cdot K/W$). The building itself is being used as a test bed to document the benefits of a number of energy efficiency improvements. As such, it was instrumented to measure the half-hourly energy consumption of the whole building and of the individual rooftop air conditioners, the roof heat fluxes and the interior air and roof temperatures. These data were used to evaluate the energy effectiveness of the roof re-covering action. The energy savings analysis was done using the DOE-2.IE building simulation program, which was calibrated to match the measured data. The roof re-covering led to around 10% cooling energy savings and around 50% heating energy savings. The resulting energy cost reductions alone are not sufficient to justify re-covered roofs for buildings having high internal loads, such as the building investigated here. However the energy savings do contribute significantly to the measure's Savings-to-Investment Ratio (SIR).

29902 (DOE/CE/23810–58) **Lean flammability limit as a fundamental refrigerant property. Phase 1, Interim technical report, 1 October 1994–31 March 1995.** Womeldorf, C.; King, M.; Grosshandler, W. National Inst. of Standards and Technology, Gaithersburg, MD (United States). Building and Fire Research Lab. 31 Mar 1995. 30p. Sponsored by USDOE, Washington, DC (United States). DOE Contract FG02-91CE23810. Order Number DE95011238. Source: OSTI; NTIS; GPO Dep.

Due to the ozone-depleting effects of commonly used chlorofluorocarbon refrigerants, safe environmentally-friendly replacements must be found. HFC-32 (CH_2F_2) and other hydrochlorofluorocarbons are potential candidates; however, in contrast with the CFCs, many of these compounds are flammable. Testing the flammability limits of these hydrochlorofluorocarbons using traditional ASTM E-681 methods has produced a range of limits depending upon the vessel and ignition source used. This project demonstrates the feasibility of defining a fundamental flammability limit of HFC-32, that occurs at the limit of a zero strain rate and is independent of ignition source. Using a counterflow twin-flame burner to define extinction points for different strain rates, an extrapolation to zero strain rate is performed. Using this technique, preliminary results on the lean flammability limit of HFC-32 and the critical flammability ratio of HFC-125 (C_2HF_5) in ETC-32 are reported.

29903 (DOE/GO–10094-040) **Tomorrow's energy today for cities and counties - Swimming pools warm up to energy-saving technologies.** National Renewable Energy Lab., Golden, CO (United States). Sep 1995. 4p. Sponsored by USDOE, Washington, DC (United States). DOE Contract AC36-83CH10093. Order Number DE95000249. Source: OSTI; NTIS; GPO Dep.

For swimming pool owners and operators who struggle to keep down costs, RSPEC! provides a way out of unnecessarily high utility bills. The program, Reduce Swimming Pool Energy Costs!, is part of the national effort to reduce energy consumption and air

pollution, thus protecting the environment. It's a partnership between the public sector and private industry to promote the use of energy-efficient products to owners and operators of institutional, commercial, and residential pools. RSPEC! recommends ways to lower operating expenses for swimming pools, such as using pool covers and solar pool-heating systems. By making a few improvements, owners and operators of publicly held pools can make sure swimmers and taxpayers alike get what they expect from public swimming facilities.

29904 (DOE/GO–10095-194) **Energy-saving tips for small businesses.** National Renewable Energy Lab., Golden, CO (United States). Sep 1995. 2p. Sponsored by USDOE, Washington, DC (United States). DOE Contract AC36-83CH10093. Order Number DE95009274. Source: OSTI; NTIS; GPO Dep.

This flyer provides proven, straightforward, energy-saving actions that could save 10% to 50% on energy bills.

29905 (DOE/OR/21400–T484) **Thermal performance of steel-framed walls. Final report.** Barbour, E. (NAHB Research Center, Inc., Upper Marlboro, MD (United States)); Goodrow, J.; Kosny, J.; Christian, J.E. Oak Ridge National Lab., TN (United States); NAHB Research Center, Inc., Upper Marlboro, MD (United States); Holometrix, Inc., Bedford, MA (United States). 21 Nov 1994. 66p. Sponsored by USDOE, Washington, DC (United States). DOE Contract AC05-84OR21400. Order Number DE96000665. Source: OSTI; NTIS; GPO Dep.

In wall construction, highly conductive members spaced along the wall, which allow higher heat transfer than that through less conductive areas, are referred to as thermal bridges. Thermal bridges in walls tend to increase heat loss and, under certain adverse conditions, can cause dust streaking ("ghosting") on interior walls over studs due to temperature differentials, as well as condensation in and on walls. Although such adverse conditions can be easily avoided by proper thermal design of wall systems, these effects have not been well understood and thermal data has been lacking. Therefore, the present study was initiated to provide (1) a better understanding of the thermal behavior of steel-framed walls, (2) a set of R-values for typical wall constructions, and (3) information that could be used to develop improved methods of predicting R-values. An improved method for estimating R-value would allow an equitable comparison of thermal performance with other construction types and materials. This would increase the number of alternative materials for walls available to designers, thus allowing them to choose the optimum choice for construction. Twenty-three wall samples were tested in a calibrated hot box (ASTM C9761) to measure the thermal performance of steel-framed wall systems. The tests included an array of stud frame configurations, exterior sheathing and fiberglass batt insulations. Other studies have not included the use of insulating sheathing, which reduces the extent of the thermal bridges and improves total thermal performance. The purpose of the project was to provide measured R-values for commonly used steel-framed wall configurations and to improve R-value estimating methods. Test results were compared to R-value estimates using the parallel path method, the isothermal planes method and the ASHRAE Zone method. The comparison showed that the known procedures do not fully account for the three-dimensional effects created by steel framing in a wall.

29906 (K/ETO–167) **New flow boiling heat transfer correlation for CFC-114 and C_4F_{10}.** Szady, A.J. (Oak Ridge National Lab., TN (United States). Engineering Technology Div.). Oak Ridge K-25 Site, TN (United States). Aug 1995. 13p. Sponsored by USDOE, Washington, DC (United States). DOE Contract AC05-84OT21400. Order Number DE95017848. Source: OSTI; NTIS; GPO Dep.

The flow boiling tests being conducted at Cudo Technologies, Ltd. in Lexington, Kentucky are a part of The GDP Coolant Replacement Project. The tests are to be done with two alternates, C_4F_{10} and C_4F_8, as well as CFC-114. So far, tests were conducted with CFC-114 and C_4F_{10}. The CFC-114 data by Cudo shows better heat transfer performance than that predicted by the codes used in the numerical model which were based on a superposition model. The data was applied to an asymptotic model developed by Steiner and Taborek. The new correlation developed seems to fit better with the Cudo data as well as the Paducah cell test data. The model will be further investigated when C_4F_8 data is available.

29907 (KRC–91H-J01) **A Study on the Development of Building Energy Analysis Program and the Establishment of BEPS.** Kong, S.R. (Korea Electric Power Corp. (KEPCO), Taejon (Korea, Republic of). Research Center); Kwon, K.J.; Yoo, Y.H.; Cho, Y.K.; Kijm, Y.D.; Han, S.W.; Kim, M.H.; Kim, K.W.; Cho, K.H.; Lee, H.W.; Lee, Y.H.; Kim, S.J.; Song, K.S.; Heon, C.T.; Choi, J.M.; KiKorea Electric Power Corp. (KEPCO), Taejon (Korea, Republic of). Research Center. 1994. 434p. (In Korean). Order Number DE96703597. Source: OSTI; NTIS (US Sales Only).

The amount of energy consumption in building covers the 30% of the total energy consumption and that of electricity is much the same. Because of the improvement of the living quality, energy consumption in building part is increasing and the rate is much higher than that of other parts. So, KEPCO, one of the major domestic energy suppliers and consumers, needs to develop reliable computerized building energy analysis program and to establish building energy performance standards for the reasonable energy management and the efficient execution of energy budget and the improvement of working condition of the corp's buildings. So the study aims to the development of computerized building energy analysis program, and the establishment energy budget level and building energy performance standards for the corp's buildings.

29908 (LBL–33934) **The use of EMCS in building monitoring: Experience from energy edge and LoanSTAR Programs.** Heinemeier, K.E. Lawrence Berkeley Lab., CA (United States). Apr 1993. 5p. Sponsored by USDOE, Washington, DC (United States);Texas A and M Univ., College Station, TX (United States). DOE Contract AC03-76SF00098. (CONF-9304296–1: National conference on building commissioning, Sacramento, CA (United States), 28-30 Apr 1993). Order Number DE95014785. Source: OSTI; NTIS; GPO Dep.

Monitoring building energy performance can provide important immediate feedback to building personnel in building commissioning, operation and maintenance. It also provides an essential "reality-check" and feedback (immediate and longer-term) in many utility efforts such as demand-side management impact evaluation, forecasting, and conservation measure technology assessment. However, monitoring can be quite expensive, often resulting in either the need to reduce experimental sample sizes (with resulting reduced accuracy) or to forgo monitoring altogether. Analysis of data from in-place Energy Management and Control Systems (EMCSs) may be an effective alternative to dedicated monitoring in many cases. EMCS-based monitoring can have several advantages: reduced cost due to the fact that the equipment has already been purchased and installed, an increased amount of available data, information on building operation, and an on-site data processing capability. The use of EMCSs for monitoring has been investigated at several sites within two different conservation programs: the Energy Edge Evaluation Project (new construction), and the Texas LoanSTAR Monitoring and Analysis Program (retrofit). The text that follows provides an overview of the potential role that EMCS-based monitoring may play in conservation efforts, and a summary of the findings of these investigations. The presentation at the National Conference on Building Commissioning will provide greater detail on the experiences with EMCS monitoring in the two conservation programs.

29909 (LBL–36603) **Utility residential new construction programs: Going beyond the code. A report from the Database on Energy Efficiency Programs (DEEP) Project.** Vine, E. Lawrence Berkeley Lab., CA (United States). Aug 1995. 115p. Sponsored by USDOE, Washington, DC (United States);Electric Power Research Inst., Palo Alto, CA (United States);New York State Energy Research and Development Authority, Albany, NY (United States). DOE Contract AC03-76SF00098. Contract BG9216800; Contract BG9228200. Order Number DE96000875. Source: OSTI; NTIS; GPO Dep.

Based on an evaluation of 10 residential new construction programs, primarily sponsored by investor-owned utilities in the United States, we find that many of these programs are in dire straits and are in danger of being discontinued because current inclusion of only direct program effects leads to the conclusion that they are

not cost-effective. We believe that the cost-effectiveness of residential new construction programs can be improved by: (1) promoting technologies and advanced building design practices that significantly exceed state and federal standards; (2) reducing program marketing costs and developing more effective marketing strategies; (3) recognizing the role of these programs in increasing compliance with existing state building codes; and (4) allowing utilities to obtain an "energy-savings credit" from utility regulators for program spillover (market transformation) impacts. Utilities can also leverage their resources in seizing these opportunities by forming strong and trusting partnerships with the building community and with local and state government.

29910 (LBL–36636) **Development of a model to simulate the performance of hydronic radiant cooling ceilings.** Stetiu, C.; Feustel, H.E. Lawrence Berkeley Lab., CA (United States). Jun 1995. 31p. Sponsored by USDOE, Washington, DC (United States);California Inst. for Energy Efficiency, Berkeley, CA (United States). DOE Contract AC03-76SF00098. Contract EXP-91-08. (CONF-950624–3: Annual meeting of the American Society of Heating, Refrigeration and Air-Conditioning Engineers, Inc. (ASHRAE), San Diego, CA (United States), 24-28 Jun 1995). Order Number DE95014789. Source: OSTI; NTIS; GPO Dep.

A significant amount of the electrical energy used to cool non-residential buildings equipped with all-air systems is drawn by the fans that transport the cool air through the thermal distribution system. Hydronic radiant cooling systems have the potential to reduce the amount of air transported through the building by separating the tasks of ventilation and thermal conditioning. Because of the physical properties of water, hydronic radiant cooling systems can transport a given amount of thermal energy using less than 5170 of the otherwise necessary fan energy. This improvement alone significantly reduces the energy consumption and peak power requirement of the air conditioning system. Hydronic radiant cooling systems have been used for more than 30 years in hospital rooms to provide a draft-free, thermally stable environment. The energy savings and peak-load characteristics of these systems have not yet been analyzed systematically. Moreover, adequate guidelines for design and control of these systems do not exist. This has prevented their widespread application to other building types. The evaluation of the theoretical performance of hydronic systems could be made most conveniently by computer models. Energy analysis programs such as DOE-2 do not have the capability to simulate hydronic radiant systems yet. In this paper the development of a model that can simulate accurately the dynamic performance of hydronic radiant cooling systems is described. The model is able to calculate loads, heat extraction rates, room air temperature and room surface temperature distributions, and can be used to evaluate issues such as thermal comfort, controls, system sizing, system configuration and dynamic response. The model was created with the Simulation Problem Analysis and Research Kernel (SPARK) developed at the Lawrence Berkeley Laboratory, which provides a methodology for describing and solving the dynamic, non-linear equations that correspond to complex physical systems.

29911 (LBL–36658) **Energy efficiency improvements for refrigerator/freezers using prototype doors containing gas-filled panel insulating systems.** Griffith, B.; Arasteh, D.; Tuerler, D. Lawrence Berkeley Lab., CA (United States). Jan 1995. 12p. Sponsored by California Inst. for Energy Efficiency, Berkeley, CA (United States);USDOE, Washington, DC (United States). DOE Contract AC03-76SF00098. (CONF-9505265–1: 46. international appliance technical conference, Urbana, IL (United States), 15-17 May 1995). Order Number DE95016456. Source: OSTI; NTIS; GPO Dep.

Energy efficiency improvements in domestic refrigerator/freezers, are directly influenced by the overall thermal performance of the cabinet and doors. An advanced system for reducing heat gain is Gas-Filled Panel thermal insulation technology. Gas-Filled Panels contain a low-conductivity, inert gas at atmospheric pressure and employ a reflective baffle to suppress radiation and convection within the gas. This paper presents energy use test results for a 1993 model 500 liter top mount refrigerator/freezer operated with its original doors and with a series of alternative prototype doors. Gas-Filled Panel technology was used in two types of prototype refrigerator/freezer doors. In one design, panels were used in composite with foam in standard metal door pans; this design yielded no measurable energy savings. In the other design, special polymer door pans were fitted with panels that fill nearly all of the available insulation volume; this design yielded a 6.5% increase in energy efficiency for the entire refrigerator/freezer. The EPA Refrigerator Analysis computer program has been used to predict the change in daily energy consumption with the alternative doors. The computer model also projects a 25% energy efficiency improvement for a refrigerator/freezer that would use Gas-Filled Panel insulation throughout the cabinet as well as the doors.

29912 (LBL–36975) **Using infrared thermography for the creation of a window surface temperature database to validate computer heat transfer models.** Beck, F.A.; Griffith, B.T.; Tuerler, D.; Arasteh, D. Lawrence Berkeley Lab., CA (United States). Apr 1995. 11p. Sponsored by USDOE, Washington, DC (United States). DOE Contract AC03-76SF00098. (CONF-9506177–3: Window innovations conference, Toronto (Canada), 8-9 Jun 1995). Order Number DE95014784. Source: OSTI; NTIS; GPO Dep.

IR thermography is well suited for resolving small differences in the thermal performance of highly insulating window systems. Infrared thermographic measurements made in conjunction with reference emitter techniques in a controlled and characterized laboratory setting can have an absolute accuracy of $\pm 0.5°C$. Quantitative infrared thermography requires that a number of sources of error related to measurement accuracy and test environmental conditions be quantified and minimized to the extent possible. Laboratory-based infrared thermography can be used to generate window surface temperature profile databases which can be used to direct the development of 2-D and 3-D finite element and finite difference method fenestration heat transfer simulation codes, identify their strengths and weaknesses, set research priorities, and validate finished modeling tools. Development of such a database is under way at Lawrence Berkeley Laboratory, and will be made available for public use.

29913 (LBL–37159) **Laboratory study of a low NO_x hot water heater with a weak-swirl burner.** Yegian, D.T.; Cheng, R.K. Lawrence Berkeley Lab., CA (United States). Jul 1995. 6p. Sponsored by USDOE, Washington, DC (United States). DOE Contract AC03-76SF00098. (CONF-951135–20: International mechanical engineering congress and exhibition - winter annual meeting of the American Society of Mechanical Engineers, San Francisco, CA (United States), 12-17 Nov 1995). Order Number DE96001113. Source: OSTI; NTIS; GPO Dep.

Due to environmental concerns and increasing regulation, manufacturers are searching for methods to reduce combustion-generated emissions from their products. Lean-burning is one recognized method for reducing NO_x emissions from gas appliances. This paper describes the performance of a laboratory, low NO_x hot water heater consisting of the premixed, lean-burning Weak-Swirl Burner (WSB) and a heat exchanger from a commercial 15 kW (50,000 Btu/h) Telstar spa heater. In order to identify an optimum design for a WSB water heater, data was gathered on the overall thermal efficiency and emission levels of NO, CO, and O_2, while varying the equivalence ratio, water flow rates, and power inputs. Results of our testing show that the WSB/Telstar system achieved thermal efficiencies of 80% while producing "ultra-low" (<25 ppM) NO emissions for equivalence ratios below 0.85. Efficiency was essentially independent of equivalence ratio, as well as NO and CO emissions.

29914 (NYSERDA–96000321) **Windows technology assessment.** Baron, J.J. New York State Energy Research and Development Authority, Albany, NY (United States). [1995]. 13p. Sponsored by New York State Energy Research and Development Authority, Albany, NY (United States). Source: OSTI; New York State Energy Research and Development Authority, Two Empire State Plaza, Suite 1901, Albany, NY 12223-1253 (United States).

This assessment estimates that energy loss through windows is approximately 15 percent of all the energy used for space heating and cooling in residential and commercial buildings in New York State. The rule of thumb for the nation as a whole is about 25 percent. The difference may reflect a traditional assumption of

single-pane windows while this assessment analyzed installed window types in the region. Based on the often-quoted assumption, in the United States some 3.5 quadrillion British thermal units (Btu) of primary energy, costing some $20 billion, is annually consumed as a result of energy lost through windows. According to this assessment, in New York State, the energy lost due to heat loss through windows is approximately 80 trillion Btu at an annual cost of approximately $1 billion.

29915 (ORNL/CON–389) **Experimental analysis of a window air conditioner with R-22 and zeotropic mixture of R-32/125/134a.** Mei, V.C.; Chen, F.C.; Carlstedt, J.; Hallden, D. Oak Ridge National Lab., TN (United States). Aug 1995. 30p. Sponsored by USDOE, Washington, DC (United States). DOE Contract AC05-84OR21400. Order Number DE96000196. Source: OSTI; NTIS; GPO Dep.

This study is the result of the cooperative research and development agreement (CRADA) between Oak Ridge National Laboratory and E.I. Du Pont De Nemours and Company, Inc., (CRADA No. 92-0161) for testing the use of heat exchangers as the evaporator and condenser in an air-conditioning rig. Heat exchangers at typical realistic operating conditions were tested with R-22 and with its potential replacement, a ternary mixture of R-32(30%)/R-125(10%)/R-134a(60%). A test rig was built that provided for operation of the low-temperature exchanger (evaporator) with flooded coils. The test results indicated that the performance of the evaporator heat exchanger using ternary mixture, in terms of cooling capacity, would be around 7.4% less than the performance using R-22. The cooling capacity for both refrigerants improved with flooded evaporator operation by 8.6% for R-22 and by 15% for ternary mixture. Compared with R-22 operation, operation with ternary mixture results in slightly higher compressor discharge pressure, lower compressor discharge temperature, slightly lower compressor power consumption, and a higher compressor high-low pressure ratio. Temperature glide for ternary mixture, for both evaporator and condenser, was clearly evident, but not as pronounced as expected because of the pressure drop (and thus the temperature drop) along the coils. Further improvement of the performance of ternary mixture is possible if the evaporator is arranged in a counter-cross-flow configuration to take advantage of the temperature glide. Current evaporator designs are mostly concurrent-cross-flow, which is more appropriate for single-component refrigerants or azeotropic refrigerant mixtures.

29916 (ORNL/M–1676) **Evaluation of Foamseal ceiling panels in the large scale climate simulator under winder conditions. Phase I.** Wilkes, K.E.; Childs, P.W. Oak Ridge National Lab., TN (United States). Nov 1991. 9p. Sponsored by USDOE, Washington, DC (United States). DOE Contract AC05-84OR21400. Order Number DE96000686. Source: OSTI; NTIS; GPO Dep.

This report serves to document Phase I of tests on ceiling panels fabricated by Foamseal Urethane Technology, Inc. in the Large Scale Climate Simulator (LSCS). The work reported here was accomplished during August, 1991.

29917 (PNL–10771) **Cost effectiveness of the 1993 model energy code in New Jersey.** Lucas, R.G. Pacific Northwest Lab., Richland, WA (United States). Sep 1995. 26p. Sponsored by USDOE, Washington, DC (United States). DOE Contract AC06-76RL01830. Order Number DE96000202. Source: OSTI; NTIS; GPO Dep.

This is an analysis of cost effectiveness the Council of American Building Officials' 1993 Model Energy Code (MEC) building thermal-envelope requirements for single-family houses and multifamily housing units in New Jersey. Goal was to compare the cost effectiveness of the 1993 MEC to the alternate allowed in the 1993 Building Officials & Code Administrators (BOCA) National Energy Conservation Code – American Society of Heating, Refrigerating, and Air-Conditioning Engineers (ASHRAE) Standard 90A-1980 – based on a comparison of the costs and benefits associated with complying with each. This comparison was performed for Camden, New Brunswick; Somerville, and Sparta. The analysis was done for two different scenarios: a "move-up" home buyer purchasing a single-family house and a "first-time" financially limited home buyer purchasing a multifamily unit. For the single-family home buyer, compliance with the 1993 MEC was estimated to increase first costs by $1028 to $1564, resulting in an incremental down payment increase of $206 to $313 (at 20% down). The time when the homeowner realizes net cash savings (net positive cash flow) for houses built in accordance with the 1993 MEC was from 1 to 5 years. The home buyer who paid 20% down had recovered increases in down payments and mortgage payments in energy cost savings by the end of the fifth year or sooner and thereafter will save more money each year. For the multifamily unit home buyer first costs were estimated to increase by $121 to $223, resulting in an incremental down payment increase of $12 to $22 (at 10% down). The time when the homeowner realizes net cash savings (net positive cash flow) for houses built in accordance with the 1993 MEC was 1 to 3 years.

29918 (PNL-SA–23973) **No maintenance – no energy efficiency.** Szydlowski, R.F.; Schliesing, J.S.; Winiarski, D.W. Pacific Northwest Lab., Richland, WA (United States). Dec 1994. 11p. Sponsored by USDOE, Washington, DC (United States). DOE Contract AC06-76RL01830. (CONF-941218–10: 17. world energy engineering congress and the 4th environmental technology congress and expo, Atlanta, GA (United States), 7-9 Dec 1994). Order Number DE95014615. Source: OSTI; NTIS; GPO Dep.

Field investigations illustrate that it is not realistic to expect new high-tech equipment to function for a full life expectancy at high efficiency without significant operations and maintenance (O&M). A simple walk through inspection of most buildings reveals extensive equipment that is being operated on manual override, is incorrectly adjusted and operating inefficiently, or is simply inoperative. This point is illustrated with two examples at Robins Air Force Base, Georgia. The first describes development of a comprehensive, base-wide, steam trap maintenance program. The second describes a measured evaluation from a typical office building. The objective of both examples was to assess the importance of proper O&M. The proposed "O&M First" philosophy will result in more efficient building HVAC operation, provide improved services to the building occupants, and reduce energy consumption and unscheduled equipment repair/replacement. Implementation of a comprehensive O&M program will result in a 15–25% energy savings. The O&M foundation that is established will allow other energy conservation activities such is demand side management or energy management and control systems, to achieve and maintain their expected energy savings.

29919 (UCRL-JC–119269) **Compounds produced by motor burnouts of refrigeration systems.** Koester, C.; Hawley-Fedder, R.; Foiles, L. Lawrence Livermore National Lab., CA (United States). 24 May 1995. 2p. Sponsored by USDOE, Washington, DC (United States). DOE Contract W-7405-ENG-48. (CONF-9505261–2: 43. American Society of Mass Spectrometry (ASMS) conference on mass spectrometry and allied topics, Atlanta, GA (United States), 21-26 May 1995). Order Number DE95017291. Source: OSTI; NTIS; GPO Dep.

The phase-out of chlorofluorocarbons has necessitated the introduction of alternate refrigerants. R22 (CF_2ClH), R134a (CF_3CH_2F), and R507 (50/50 CHF_2CF_3/CF_3CH_3) are newer fluids which are used in cooling systems. Recently, concern over the possible formation of toxic compounds during electrical arcing through these fluids has prompted us to identify their electrical breakdown products by electron ionization GC/MS. For example, it is known that perfluoroisobutylene (PFIB), which have an threshold limit value of 10 ppb (set by the American Conference of Government Industrial Hygienists), is produced from the thermal and electrical breakdown of some refrigerants. We have used specially designed test cells, equipped with electrodes, to simulate the electrical breakdown of R22, R134a, and R507 in refrigeration systems.

29920 (UCRL-JC–121345-Pt.2) **Seismic shock and vibration isolation 1995. Part 2: Applications.** Mok, G.C. (Lawrence Livermore National Lab., CA (United States)); Chung, H.H. Lawrence Livermore National Lab., CA (United States). 11 Jul 1995. 5p. Sponsored by USDOE, Washington, DC (United States). DOE Contract W-7405-ENG-48. (CONF-950740–97-Pt.2: Joint ASME/JSME pressure vessels and piping conference, Honolulu, HI (United States), 23-27 Jul 1995). Order Number DE96000089. Source: OSTI; NTIS; GPO Dep.

As pointed out in the introduction of Part 1, the isolation strategy can be used to effectively decouple a' structure from its environment and thus the structure can be protected from damaging seismic loads or unwanted vibrations and noises from the environment. The method has been used for solving vibration and shock problems in machinery and equipment for many years, but its application to the protection of structures from seismic loadings is relatively recent. Owing to the current interest generated by the Northridge and Kobe earthquakes, an but one of the papers in this publication deal with seismic isolation. The one paper on vibration isolation by Yonekura discusses a measure to protect buildings from detrimental excitations of running trains. Seismic or base isolation has been used to protect bridges, buildings, industrial facilities, and nuclear reactors from damaging seismic loads since 1970. For each of these applications base isolation offers some unique advantages that the conventional strengthening method cannot. Some of these advantages are discussed in papers presented in this publication.

3202 Transportation

Refer also to citation(s) 29282, 29974, 29976

29921 (LA-UR–95-1664) **TRANSIMS: TRansportation ANalysis and SIMulation System.** Smith, L.; Beckman, R.; Anson, D.; Nagel, K.; Williams, M. Los Alamos National Lab., NM (United States). [1995]. 8p. Sponsored by Department of Transportation, Washington, DC (United States). DOE Contract W-7405-ENG-36. (CONF-9504197–1: 5. National transportation planning methods applications conference, Seattle, WA (United States), 17-21 Apr 1995). Order Number DE95016428. Source: OSTI; NTIS; GPO Dep.

This paper summarizes the TRansportation ANalysis and SIMulation System (TRANSIMS) Project, the system's major modules, and the project's near-term plans. TRANSIMS will employ advanced computational and analytical techniques to create an integrated regional transportation systems analysis environment. The simulation environment will include a regional population of individual travelers and freight loads with travel activities and plans, whose individual interactions will be simulated on the transportation system, and whose environmental impact will be determined. We will develop an interim operational capability (IOC) for each major TRANSIMS module during the five-year program. When the IOC is ready, we will complete a specific case study to confirm the IOC features, applicability, and readiness.

29922 (ORNL/TM–13050) **Anticipatory precrash restraint sensor feasibility study: Final report.** Kercel, S.W.; Dress, W.B. Oak Ridge National Lab., TN (United States). Aug 1995. 75p. Sponsored by Department of Transportation, Washington, DC (United States). DOE Contract AC05-84OR21400. Order Number DE96000845. Source: OSTI; NTIS; GPO Dep.

This report explores feasibility of an anticipatory precrash restraint sensor. The foundation principle is the anticipation mechanism found at a primitive level of biological intelligence and originally formalized by the mathematical biologist Robert Rosen. A system based on formal anticipatory principles should significantly outperform conventional technologies. It offers the prospect of high payoff in prevention of death and injury. Sensors and processes are available to provide a good, fast, and inexpensive description of the present dynamical state of the vehicle to the embedded system model in the anticipation engine. The experimental part of this study found that inexpensive radar in a real-world setting does return useful data on target dynamics. The data produced by a radar system can be converted to target dynamical information by good, fast and inexpensive signal-processing techniques. Not only is the anticipatory sensor feasible, but further development under the sponsorship of the National Highway Traffic Safety Administration is necessary and desirable. There are a number of possible lines of follow-on investigation. The level of effort and expected benefits of various alternatives are discussed.

29923 (UCRL-ID–119841) **Recommendations for a commercial vehicle to roadway communications national standard.** Davis, D.T. Lawrence Livermore National Lab., CA (United States). Feb 1995. 8p. Sponsored by USDOE, Washington, DC (United States). DOE Contract W-7405-ENG-48. Order Number DE96000842. Source: OSTI; NTIS; GPO Dep.

This is the final report by the Lawrence Livermore National Laboratory (LLNL). Based on the authors studies of the Electronic Toll and Traffic Management (ETTM) industry, they make recommendations for a possible future national standard for short range Vehicle-to-Roadway Communications (VRC) for Commercial Vehicle Operations (CVO). Of primary interest to the Federal Highway Administration are Mainline Automated Clearance Systems (MACS). In such a system, CVs would exchange data with weigh-stations and ports of entry at highway speeds using wireless Radio Frequency (RF) techniques and to enable automated clearance. The CV would carry a transponder (or tag) and transmit electronic credentials, safety data, in-transit data, etc. on command from a roadside transceiver (or reader) upstream from the weigh-station or port of entry. Computer processing of this data, plus the weigh-in-motion reading and historical information, would be used to decide whether to direct the truck to stop for manual clearance or proceed.

3203 Industrial and Agricultural Processes

Refer also to citation(s) 28657, 28827, 28833, 28983, 29201, 29237, 29244, 29268, 29274, 29313, 29357, 29360, 29363, 29364, 29800, 29849, 29906, 29957, 30133, 30309, 30372, 30374

29924 (CONF-890351–, pp. 197-207) **Preliminary TES design optimization study for a simple periodic brick plant.** Drake, J.B. (Oak Ridge National Lab., TN (United States)); Olszewski, M.; Solomon, A.D. USDOE Assistant Secretary for Conservation and Renewable Energy, Washington, DC (United States). Office of Energy Management; Pacific Northwest Lab., Richland, WA (United States); Oak Ridge National Lab., TN (United States). Mar 1989. DOE Contract AC05-84OR21400. From Thermal energy storage program review; New Orleans, LA (United States); 15-17 Mar 1989. In *U.S. Department of Energy thermal energy storage research activities review: 1989 Proceedings*. 357p. Order Number DE95016394. Source: OSTI; NTIS; GPO Dep.

A general optimization method has been developed for maximizing the return on investment for a brick plant re-using waste heat with the capability of storing energy over periods when a kiln is not operating. The duct connections between devices and storage along with the operating schedule of flow rates in these ducts are the independent variables available for control. A combination of combinatorial search algorithms along with a dynamic programming model and the simplex method are layered to provide the optimization technique.

29925 (DOE/CE/15554–T5) **Develop apparatus and process for second-stage drying. Quarterly progress report, June 27, 1995–September 26, 1995.** Taylor, F.; Bouchillon, C.W. Mississippi Forest Products Utilization Lab., Mississippi State, MS (United States). 2 Oct 1995. 13p. Sponsored by USDOE, Washington, DC (United States). DOE Contract FG01-94CE15554. Order Number DE96000690. Source: OSTI; NTIS; GPO Dep.

The fourth quarter progress has been directed at testing experimental apparatus for the laboratory scale heat exchanger models.

29926 (DOE/CE/23810–54) **Sealed tube comparisons of the compatibility of desiccants with refrigerants and lubricants. Final report, August 1993–January 1995.** Field, J.E. Spauschus Associates, Inc., Stockbridge, GA (United States). May 1995. 92p. Sponsored by USDOE, Washington, DC (United States). DOE Contract FG02-91CE23810. Order Number DE95017582. Source: OSTI; NTIS; GPO Dep.

Continuing environmental concerns mandate replacement of CFC's with alternate refrigeration fluids. Until now, relatively little testing had been reported in the literature for compatibility of desiccants in these new working fluids. Using bench scale test methods generally accepted throughout the industry today, this work provides data necessary to assess the compatibility of virtually all of the currently used desiccant types - both bead and molded core, with thirteen refrigerant/lubricant combinations. The desiccants have been tested by exposure to refrigerant and lubricant in sealed, glass tubes in accordance with ASHRAE/ANSI Standard

97-1989. After aging, the liquid phase was evaluated for acid anion formation, change in color, and presence of halide ions, the gas phase was analyzed for refrigerant decomposition by gas chromatography, and the desiccants were evaluated for changes in crush strength and for retention of acids and halide ions. Metal catalysts, also present in the sealed tubes, were visually examined for corrosion, copper plating, and appearance changes.

29927 (DOE/EH–96000181) **Universal waste rule: Final rule issued. Environmental Guidance Regulatory Bulletin.** USDOE Assistant Secretary for Environment, Safety, and Health, Washington, DC (United States). RCRA/CERCLA Div. 14 Aug 1995. 6p. Sponsored by USDOE, Washington, DC (United States). Order Number DE96000181. Source: OSTI; NTIS; GPO Dep.

On February 11, 1993, EPA proposed to streamline the management requirements for certain hazardous wastes that were generated in large quantities by a variety of generators (i.e., residential, small businesses, industries, etc.). EPA's intention was to facilitate the environmentally sound collection and disposal of these types of wastes. In this proposed rule, EPA termed these types of hazardous wastes "universal wastes" and developed a management system which was less stringent than the existing Subtitle C regulations. EPA proposed that the following three types of hazardous wastes be managed as universal wastes: batteries, certain pesticides, and thermostats. Because EPA believed that the authority to propose the promulgation of the universal waste rule was not significantly linked to HSWA provisions, the Agency proposed the promulgation of the universal waste rule under pre-HSWA authority. On May 11, 1995, at FR 25492, EPA promulgated a pre-HSWA rule that streamlined hazardous waste management regulations for universal wastes.

29928 (DOE/EIA–0552(85-91)) **Changes in energy intensity in the manufacturing sector 1985–1991.** USDOE Energy Information Administration, Washington, DC (United States). Office of Energy Markets and End Use. 15 Sep 1995. 127p. Sponsored by USDOE, Washington, DC (United States). Order Number DE96001072. Source: OSTI; NTIS; GPO; GPO Dep.

In this report, energy intensity is defined as the ratio of energy consumption per unit of output. Output is measured as the constant dollar of value of shipments and receipts, and two measures of energy consumption are presented in British thermal units (Btu): Offsite-Produced Energy and Total Inputs of Energy. A decrease in energy intensity from one period to another suggests an increase in energy efficiency, and vice versa. Energy efficiency can be defined and measured in various ways. Certain concepts of energy efficiency, especially those limited to equipment efficiencies, cannot be measured over time using changes in energy-intensity ratios. While improved energy efficiency will tend to reduce energy intensity, it is also true that a change in energy intensity can be due to factors unrelated to energy efficiency. For this report, energy intensity is used as a surrogate measure for energy efficiency, based on industry knowledge and current methodological analyses.

29929 (DOE/OR/21400–T493) **Use of electric fields to enhance industrial chemical processing. Final report.** Scott, T.C.; Bowe, M.D. Oak Ridge National Lab., TN (United States). [1995]. 10p. Sponsored by USDOE, Washington, DC (United States). DOE Contract AC05-84OR21400. Order Number DE96000674. Source: OSTI; NTIS; GPO Dep.

This report describes the use of electric fields applied to chemical processing. In particular, the application was made to a ROHM & HAAS polymer suspension for the removal of organic compounds utilizing solvent extraction. Results are described.

29930 (ELFORSK–95-10(B)) **Preliminary study - Experiences and observations in the efficiency projects of SEU.** Hoejeberg, M. (Hoejeberg Analys och Information AB (Sweden)). Elforsk AB, Stockholm (Sweden). 1995. 25p. (In Swedish). Order Number DE96703695. Source: OSTI; NTIS.

During the period 1988-1994 SEU (the R and D organization of Swedish electric utilities) has given 45 MSEK in financial support to 60 projects concerned with efficient use of electric energy. In this report the projects are grouped according to the consumer sector (Industry, Buildings, Dwellings) and to the objective of the project (Mapping, System improvement, Product installation, Energy services etc) in order to facilitate the future analysis. Some preliminary conclusions are drawn about the possibilities for the utilities to achieve the efficiency goals. 3 tabs

29931 (EPA/600/S–95/008) **Waste minimization assessment for a manufacturer of iron castings and fabricated sheet metal parts.** Fleischman, M.; Harris, J.J.; Handmaker, A.; Looby, G.P. Environmental Protection Agency, Cincinnati, OH (United States). Aug 1995. 6p. Sponsored by Environmental Protection Agency, Washington, DC (United States). Source: OSTI; NTIS.

The U.S. Environmental Protection Agency (EPA) has funded a pilot project to assist small and medium-size manufacturers who want to minimize their generation of waste but who lack the expertise to do so. Waste Minimization Assessment Centers (WMACs) were established at selected universities and procedures were adapted from the EPA Waste Minimization Opportunity Assessment Manual. That document has been superseded by the Facility Pollution Prevention Guide. The WMAC team at the University of Louisville performed an assessment at a plant that manufactures iron castings and fabricated sheet metal parts. Foundry operations include mixing and mold formation, core making, metal pouring, shakeout, finishing, and painting. Cutting, shaping, and welding are the principal metal fabrication operations. The team's report, detailing findings and recommendations indicated that paint-related wastes are generated in large quantities, and that significant waste reduction and cost savings could be realized by installing a dry powder coating system or by replacing conventional air spray paint guns with high-volume low-pressure spray guns. This research brief was developed by the principal investigators and EPA's National Risk Management Research Laboratory, Cincinnati, OH, to announce key findings of an ongoing research project that is fully documented in a separate report of the same title available from University City Science Center.

29932 (EPA–600/S-95/012) **Environmental research brief: Pollution prevention assessment for a manufacturer of automotive lighting equipment and accessories.** Fleischman, M. (Tennessee Univ., Knoxville, TN (United States). Dept. of Engineering Science and Mechanics); Couch, B.; Handmaker, A.; Looby, G.P. National Risk Management Research Lab., Cincinnati, OH (United States). Aug 1995. 7p. Sponsored by Environmental Protection Agency, Washington, DC (United States). Order Number DE96001532. Source: OSTI; NTIS.

The US Environmental Protection Agency (EPA) has funded a Pilot project to assist small and medium-size manufacture who want to minimize their generation of waste but who lac the expertise to do so. In an effort to assist these manufacturers Waste Minimization Assessment Centers (WMACs) we established at selected universities and procedures were adapted from the EPA Waste Minimization Opportunity Assessment Manual. The WMAC team at the University of Tennessee performed an assessment at a plant that manufactures outboard motors for water craft. Three basic subunits received from other manufacturing plants undergo primarily painting and assembly operations in order to produce the final product. The team's report, detailing findings and recommendations, indicated that paint overspray waste and spent clean-up solvent are generated in large quantities and that significant cost savings could be achieved by installing robotic paint application equipment. This Research Brief was developed by the principal investigators and EPA's National Risk Management Research Laboratory, Cincinnati, OH, to announce key findings of an ongoing research project that is fully documented in a separate report of the same title available from University City Science Center.

29933 (EPA–600/S-95/013) **Environmental research brief: Pollution prevention assessment for a manufacturer of locking devices.** Jendrucko, R.J. (Tennessee Univ., Knoxville, TN (United States). Dept. of Engineering Science and Mechanics); Hurst, B.T.; Looby, G.P. National Risk Management Research Lab., Cincinnati, OH (United States). Aug 1995. 6p. Sponsored by Environmental Protection Agency, Washington, DC (United States). Order Number DE96001533. Source: OSTI; NTIS.

The US Environmental Protection Agency (EPA) has funded a pilot project to assist small and medium-size manufacturers who want to minimize their generation of waste but who lack the expertise to

do so. In an effort to assist these manufacturers Waste Minimization Assessment Centers (WMACs) were established at selected universities and procedures were adapted from the EPA Waste Minimization Opportunity Assessment Manual (EPA/625/7-88/003, July 1988). That document has been superseded by the Facility Pollution Prevention Guide (EPA/600/R-92/088). The WMAC team at the University of Tennessee performed an assessment at a plant that fabricates and finishes metal components that are assembled into several types of locking devices. Raw materials are machined and then shipped offsite for heat-treating, stored until needed, or buffed and cleaned. Then, all parts other than those made of stainless steel are electroplated, electrostatically powder coated, or lacquer coated. The various component parts are then assembled into the locking devices. The assessment team's report, detailing findings and recommendations, indicated that the vapor degreasers generate a significant amount of waste and that vapor degreasing could be replaced with an aqueous cleaning system for intermediate cleaning. This Research Brief was developed by the principal investigators and EPA's National Risk Management Research Laboratory, Cincinnati, OH, to announce key findings of an ongoing research project that is fully documented in a separate report of the same title available from University City Science Center.

29934 (EPA–600/S-95/016) **Environmental research brief: Pollution prevention assessment for a manufacturer of metal fasteners.** Jendrucko, R.J. (Tennessee Univ., Knoxville, TN (United States). Dept. of Engineering Science and Mechanics); Coleman, T.N.; Looby, G.P. National Risk Management Research Lab., Cincinnati, OH (United States). Aug 1995. 4p. Sponsored by Environmental Protection Agency, Washington, DC (United States). Order Number DE96001535. Source: OSTI; NTIS.

The US Environmental Protection Agency (EPA) has funded a pilot project to assist small and medium-size manufacturers who want to minimize their generation of waste but who lack the expertise to do so. In an effort to assist these manufacturers Waste Minimization Assessment Centers (WMACs) were established at selected universities and procedures were adapted from the EPA Waste Minimization Opportunity Assessment Manual (EPA/625/7-88/003, July 1988). That document has been superseded by the Facility Pollution Prevention Guide (EPA/600/R-92/088, May 1992). The WMAC team at the University of Tennessee performed an assessment at a plant that manufactures various types of metal fasteners for automobiles, furniture, and appliances. Products are manufactured from steel, brass, copper, and aluminum wire and rod stock in two production lines-large part production and small part production. In large part production, header machines press wire stock into specific product shapes which are washed, machined, and in some cases heat-treated and polished. Small parts are manufactured from wire and rod stock in a series of machining operations, then washed, heat treated and polished, before shipment to an outside firm for surface finishing. The team's report, detailing findings and recommendations indicated that a large amount of plant oil waste is shipped off-site for fuels blending and a significant quantity of oily sludge waste is shipped offsite for disposal as nonhazardous waste. Large cost savings can be achieved by the plant through the use of alternative methods of removing metal chips from parts, thereby reducing intermediate washings.

29935 (EPA–600/S-95/018) **Environmental research brief: Pollution prevention assessment for a manufacturer of outboard motors.** Jendrucko, R.J. (Tennessee Univ., Knoxville, TN (United States). Dept. of Engineering Science and Mechanics); Coleman, T.N.; Looby, G.P. National Risk Management Research Lab., Cincinnati, OH (United States). Sep 1995. 6p. Sponsored by Environmental Protection Agency, Washington, DC (United States). Order Number DE96001536. Source: OSTI; NTIS.

The US Environmental Protection Agency (EPA) has funded a Pilot project to assist small and medium-size manufacture who want to minimize their generation of waste but who lac the expertise to do so. In an effort to assist these manufacturers Waste Minimization Assessment Centers (WMACs) we established at selected universities and procedures were adapted from the EPA Waste Minimization Opportunity Assessment Manual. The WMAC team at the University of Tennessee performed an assessment at a plant that manufactures outboard motors for water craft. Three basic subunits received from other manufacturing plants undergo primarily painting and assembly operations in order to produce the final product. The team's report, detailing findings and recommendations, indicated that paint overspray waste and spent clean-up solvent are generated in large quantities and that significant cost savings could be achieved by installing robotic paint application equipment. This Research Brief was developed by the principal investigators and EPA's National Risk Management Research Laboratory, Cincinnati, OH, to announce key findings of an ongoing research project that is fully documented in a separate report of the same title available from University City Science Center.

29936 (EPA–600/S-95/022) **Environmental Research Brief: Pollution prevention assessment for a manufacturer of rebuilt industrial crankshafts.** Edwards, H.W. (Colorado State Univ., Fort Collins, CO (United States). Dept. of Mechanical Engineering); Kostrzewa, M.F.; Looby, G.P. National Risk Management Research Lab., Cincinnati, OH (United States). Aug 1995. 5p. Sponsored by Environmental Protection Agency, Washington, DC (United States). Order Number DE96001537. Source: OSTI; NTIS.

The Waste Minimization Assessment Center at Colorado State University performed an assessment at a plant that refurbishes large industrial crankshafts. The team report indicated that the waste stream generated in the greatest quantity is spent cutting fluid from the grinding of crankshafts and that significant cost savings could be achieved by implementing a formal cutting fluid management program. This research brief discusses the process, existing waste management practices, pollution prevention opportunities, and gives additional recommendations. Tables summarize current waste generation and recommended pollution prevention opportunities.

29937 (EPA–600/S-95/023) **Environmental Research Brief: Pollution prevention assessment for a Manufacturer of pressure-sensitive adhesive tape.** Edwards, H.W. (Colorado State Univ., Fort Collins, CO (United States). Dept. of Mechanical Engineering); Kostrzewa, M.F.; Looby, G.P. National Risk Management Research Lab., Cincinnati, OH (United States). Aug 1995. 5p. Sponsored by Environmental Protection Agency, Washington, DC (United States). Order Number DE96001538. Source: OSTI; NTIS.

The Waste Minimization Assessment Center at Colorado State University performed an assessment at a plant that manufactures three varieties of pressure-sensitive tape. The team report indicated that waste natural rubber adhesive is shipped offsite for disposal in large quantities, and that singificant cost savings could be achieved by redesigning the adhesive applicator on the coater for natural rubber adhesive. This research brief discusses the manufacturing process, existing waste management practices, pollution prevention opportunities, and gives additional recommendations. Tables summarize current waste generation and recommended pollution prevention opportunity.

29938 (EPA–600/S-95/030) **Environmental Research Brief: Pollution prevention assessment for a manufacturer of pharmaceuticals.** Edwards, H.W. (Colorado State Univ., Fort Collins, CO (United States). Dept. of Mechanical Engineering); Kostrzewa, M.F.; Looby, G.P. National Risk Management Research Lab., Cincinnati, OH (United States). Aug 1995. 5p. Sponsored by Environmental Protection Agency, Washington, DC (United States). Order Number DE96001539. Source: OSTI; NTIS.

The Waste Minimization Assessment Center at Colorado State Univ. performed an assessment at a plant that manufactures intermediates for pharmaceuticals and other chemicals. Waste streams generated in the greatest quantities are waste solvents that are reused onsite, incinerated as fuel in an onsite boiler, or shipped offsite for disposal. The greatest cost savings could be achieved by reusing additional amounts of methylene chloride in the plant. This research brief discusses the process, existing waste management practices, pollution prevention opportunities, and gives additional recommendations. Tables summarize current waste generation and recommended waste minimization opportunities.

29939 (EPA–600/S-95/031) **Environmental research brief: Pollution prevention assessment for a manufacturer of components for outboard motors.** Jendrucko, R.J. (Tennessee Univ.,

Knoxville, TN (United States). Dept. of Engineering Science and Mechanics); Coleman, T.N.; Looby, G.P. National Risk Management Research Lab., Cincinnati, OH (United States). Aug 1995. 4p. Sponsored by Environmental Protection Agency, Washington, DC (United States). Order Number DE96001540. Source: OSTI; NTIS.

The US Environmental Protection Agency (EPA) has funded a Pilot project to assist small and medium-size manufacture who want to minimize their generation of waste but who lac the expertise to do so. In an effort to assist these manufacturers Waste Minimization Assessment Centers (WMACs) we established at selected universities and procedures were adapted from the EPA Waste Minimization Opportunity Assessment Manual. The WMAC team at the University of Tennessee performed an assessment at a plant that manufactures outboard motors for water craft. Three basic subunits received from other manufacturing plants undergo primarily painting and assembly operations in order to produce the final product. The team's report, detailing findings and recommendations, indicated that paint overspray waste and spent clean-up solvent are generated in large quantities and that significant cost savings could be achieved by installing robotic paint application equipment. This Research Brief was developed by the principal investigators and EPA's National Risk Management Research Laboratory, Cincinnati, OH, to announce key findings of an ongoing research project that is fully documented in a separate report of the same title available from University City Science Center.

29940 (EPA–600/S-95/032) **Environmental research brief: Pollution prevention assessment for a manufacturer of aircraft landing gear.** Jendrucko, R.J. (Tennessee Univ., Knoxville, TN (United States). Dept. of Engineering Science and Mechanics); Morton, S.D.; Thomas, T.M.; Looby, G.P. National Risk Management Research Lab., Cincinnati, OH (United States). Aug 1995. 4p. Sponsored by Environmental Protection Agency, Washington, DC (United States). Order Number DE96001541. Source: OSTI; NTIS.

The US Environmental Protection Agency (EPA) has funded a Pilot project to assist small and medium-size manufacture who want to minimize their generation of waste but who lac the expertise to do so. In an effort to assist these manufacturers Waste Minimization Assessment Centers (WMACs) we established at selected universities and procedures were adapted from the EPA Waste Minimization Opportunity Assessment Manual. The WMAC team at the University of Tennessee performed an assessment at a plant that manufactures outboard motors for water craft. Three basic subunits received from other manufacturing plants undergo primarily painting and assembly operations in order to produce the final product. The team's report, detailing findings and recommendations, indicated that paint overspray waste and spent clean-up solvent are generated in large quantities and that significant cost savings could be achieved by installing robotic paint application equipment. This Research Brief was developed by the principal investigators and EPA's National Risk Management Research Laboratory, Cincinnati, OH, to announce key findings of an ongoing research project that is fully documented in a separate report of the same title available from University City Science Center.

29941 (LA-UR–95-2720) **The application of a neural network methodology to the analysis of a dyeing operation.** Hench, K.W. (New Mexico State Univ., Las Cruces, NM (United States). Dept. of Industrial Engineering); Al-Ghanim, A.M. Los Alamos National Lab., NM (United States). [1995]. 10p. Sponsored by USDOE, Washington, DC (United States). DOE Contract W-7405-ENG-36. (CONF-9511121–1: ANNIE '95: artificial neural networks in engineering, St. Louis, MO (United States), 12-15 Nov 1995). Order Number DE95016949. Source: OSTI; NTIS; GPO Dep.

The purpose of a dyeing process is to impart into a fiber a color that has desirable qualities through the use of a bath solution. The success of an operation is dependent on a variety of factors including fiber content, dye composition, dyebath pH, time, and temperature. In the event of a failed run, the addition of a correct amount of each dye that will move the dye run from a fail condition to a pass condition is a subjective judgement of an experienced operator. This paper presents a neural network approach for analyzing the dyeing process. Predictions of dye additions were obtained with promising results.

29942 (NREL/CP–200-8098, pp. 372-381) **3 MW to 6 MW Sawmill Energy Displacement Plants featuring.** Lefcort, M.D. (Heuristic Engineering, Inc., Vancouver (Canada)); Cousins, R.J.; Skodje, E.L.S. National Renewable Energy Lab., Golden, CO (United States). [1995]. (CONF-9508104–: 2. meeting on biomass of the Americas, Portland, OR (United States), 21-24 Aug 1995). In *Second biomass conference of the Americas: Energy, environment, agriculture, and industry. Proceedings.* 1741p. Order Number DE95009230. Source: OSTI.

The British Columbia Ministry of Environment has announced that particulate emissions from about half the Province's 150 sawmill beehive burners (also known as tee-pee and wigwam burners) must not exceed 120 mg/Nm^3 (0.05 grains/sdcf)beginning 1996 January 1st. The remaining beehive burners have another two years before they too have to comply. The Heuristic EnvirOcycler can replace existing beehive burners. The EnvirOcycler is a stand-alone, two-stage combustor (updraft gasification followed by cyclonic combustion) which meets the new BC particulate limit and from which sensible heat can be recovered. Versions of this combustor have been in continuous service in the forest products industry for over 14 years. This paper describes two Self Generating, Load Displacing sawmill installations which feature an EnvirOcycler as part of an Energy Displacement Plant. An Energy Displacement Plant includes hot oil generators and recuperated gas turbine generator sets. The first installation is that of a 120 Million board feet per year sawmill (about 450,000 m^3 of logs) and features a 100 GJ/h EnvirOcycler, 48 GJ/h of hot oil heat recovery for lumber drying as well as building heat and a 3W recuperated gas turbine driven generator. The second installation is for a 150 Million board feet per year sawmill (about 550,000 m^3 of logs). It features a 130 GJ/h EnvirOcycler, 30 GJ/h of dry kiln hot oil heat recovery and 6 MW of recuperated gas turbine driven electrical generation. An analysis was conducted to determine what the Equivalent Disposal Cost of each ton of wet wood waste is assuming revenue streams from the displacement of natural gas and electricity and from the sale of electricity during weekends and graveyard shifts. A 20% return on equity was stipulated.

29943 (NREL/CP–200-8098, pp. 724-733) **Bio-energy Recovery Systems for brewery wastewater management.** Beers, A.R. (Anheuser-Busch Companies, Inc., St. Louis, MO (United States)). National Renewable Energy Lab., Golden, CO (United States). [1995]. (CONF-9508104–: 2. meeting on biomass of the Americas, Portland, OR (United States), 21-24 Aug 1995). In *Second biomass conference of the Americas: Energy, environment, agriculture, and industry. Proceedings.* 1741p. Order Number DE95009230. Source: OSTI.

Anheuser-Busch has installed anaerobic wastewater pretreatment systems or "Bio-Energy Recovery Systems" (BERS) at six breweries in the U.S. The primary purpose of BERS is the removal of soluble organic matter (grain liquor, waste beer, cleaning solutions) from wastewater in order to reduce the impact on downstream treatment works, either privately or publicly held. A byproduct of the anaerobic process is biogas (75% methane) which is used in the plants' boilers to create steam. A history of Anheuser-Busch's wastewater management philosophy is discussed including the adoption and refinement of various treatment methods. A case study is presented, demonstrating by way of an energy balance the savings realized by BERS installation. Finally, the environmental benefits of these projects are displayed in a life cycle analysis.

29944 (NREL/CP–433-7748, pp. 211-215) **The application of molecular beam mass spectrometry to the problem of plastics recycling through intelligent chemical processing.** Elam, C.C. (National Renewable Energy Lab., Golden, CO (United States)); Meglen, R.R.; Tatsumoto, K. National Renewable Energy Lab., Golden, CO (United States). Mar 1995. (CONF-9410343–: Applications of free-jet, molecular beam, mass spectrometric sampling conference, Estes Park, CO (United States), 11-14 Oct 1994). In *Applications of free-jet, molecular beam, mass spectrometric sampling: Proceedings.* 305p. Order Number DE95004052. Source: OSTI; NTIS; GPO Dep.

The increased use of mixed plastics and composites has presented a difficult problem for recycling. Selective pyrolysis can be used to thermally and catalytically recover the starting material(s)

or other high-value chemicals from mixed plastic waste streams. This technique is currently being applied to the development and scale-up of chemical recycling techniques for a variety of mixed polymer waste streams such as nylon-6 carpet, polyurethane foam, polyester/cotton blends, and mixed waste bottles. Numerous small scale screening experiments are necessary prior to scale-up to identify the appropriate catalyst(s) and conditions to optimize the separation and recovery for each of the waste streams. Milligram scale experiments can be studied using pyrolysis molecular beam mass spectrometer (py-MBMS). The effective quenching of species in their sampled state through free-jet expansion makes py-MBMS a valuable tool for identifying pyrolysis products. Characterization, property prediction, product identification, catalyst selection and parameter optimization are all aided by applying multivariate statistical techniques to py-MBMS data. The large database generated in these studies makes it possible to extract information to gain insight into optimal process conditions for larger scale processes. Py-MBMS spectra for new waste streams can also be collected and projected into the database for qualitative and quantitative identification. Nearest neighbor(s) identification narrows the array of possible recycling pathways. As the database grows, the time for evaluation of recycling processes for new waste streams can be dramatically reduced. Intelligent chemical processing (ICP) is the application of the information gained at the laboratory scale to the definition and development of new recycling technologies.

29945 (ORNL/TM–12963, pp. 229-234) **Chemical recycling of mixed waste plastics by selective pyrolysis.** Tatsumoto, K. (National Renewable Energy Laboratory, Golden, CO (United States)); Meglen, R.; Evans, R. Oak Ridge National Lab., TN (United States). May 1995. In *Advanced Industrial Materials (AIM) Program. Annual progress report, FY 1994.* 341p. Order Number DE95016129. Source: OSTI; NTIS; GPO Dep.

The goal of this work is to use selective pyrolysis to produce high-value chemicals from waste plastics mixtures. Selectivity is achieved by exploiting differences in reaction rates, catalysis, and coreactants. Target wastes are molecular mixtures such as; blends or composites, or mixtures from manufactured products such as; carpets and post-consumer mixed-plastic wastes. The experimental approach has been to use small-scale experiments using molecular beam mass spectrometry (MBMS), which provides rapid analysis of reaction products and permits rapid screening of process parameters. Rapid screening experiments permit exploration of many potential waste stream applications for the selective pyrolysis process. After initial screening, small-scale, fixed-bed and fluidized-bed reactors are used to provide products for conventional chemical analysis, to determine material balances, and to test the concept under conditions that will be used at a larger scale. Computer assisted data interpretation and intelligent chemical processing are used to extract process-relevant information from these experiments. An important element of this project employs technoeconomic assessments and market analyses of durables, the availability of other wastes, and end-product uses to identify target applications that have the potential for economic success.

29946 (SAND–95-0958C) **Plasma cleaning techniques and future applications in environmentally conscious manufacturing.** Ward, P.P. Sandia National Labs., Albuquerque, NM (United States). [1995]. 10p. Sponsored by USDOE, Washington, DC (United States). DOE Contract AC04-94AL85000. (CONF-951033–15: 27. international technical conference of the Society for the Advancement of Material and Process Engineering (SAMPE): diversity into the next century, Albuquerque, NM (United States), 9-12 Oct 1995). Order Number DE95014839. Source: OSTI; NTIS; GPO Dep.

Plasmas have frequently been used in industry as a last step surface preparation technique in an otherwise predominantly wet-etch process. The limiting factor in the usefulness of plasma cleaning techniques has been the rate at which organic materials are removed. Recent research in the field of plasma chemistry has provided some understanding of plasma processes. By controlling plasma conditions and gas mixtures, ultra-fast plasma cleaning and etching is possible. With enhanced organic removal rates, plasma processes become more desirable as an environmentally sound alternative to traditional solvent or acid dominated process, not only as a cleaning tool, but also as a patterning and machining tool. In this paper, innovations in plasma processes are discussed including enhanced plasma etch rates via plasma environment control and aggressive gas mixtures. Applications that have not been possible with the limited usefulness of past plasma processes are now approaching the realm of possibility. Some of these possible applications will be discussed along with their impact to environmentally conscious manufacturing.

29947 (SAND–95-1080) **Manufacturing technologies.** Sandia National Labs., Albuquerque, NM (United States). [1995]. 20p. Sponsored by USDOE, Washington, DC (United States). DOE Contract AC04-94AL85000. Order Number DE95017798. Source: OSTI; NTIS; GPO Dep.

The Manufacturing Technologies Center is an integral part of Sandia National Laboratories, a multiprogram engineering and science laboratory, operated for the Department of Energy (DOE) with major facilities at Albuquerque, New Mexico, and Livermore, California. Our Center is at the core of Sandia's Advanced Manufacturing effort which spans the entire product realization process.

29948 (SAND–95-1143C) **Agile robotic edge finishing system research.** Powell, M.A. Sandia National Labs., Albuquerque, NM (United States). [1995]. 25p. Sponsored by USDOE, Washington, DC (United States). DOE Contract AC04-94AL85000. (CONF-9509206–1: Finishing '95 conference and exposition, Cincinnati, OH (United States), 19-21 Sep 1995). Order Number DE95014843. Source: OSTI; NTIS; GPO Dep.

This paper describes a new project undertaken by Sandia National Laboratories to develop an agile, automated, high-precision edge finishing system. The project has a two-year duration and was initiated in October, 1994. This project involves re-designing and adding additional capabilities to an existing finishing workcell at Sandia; and developing intelligent methods for automating process definition and for controlling finishing processes. The resulting system will serve as a prototype for systems that will be deployed into highly flexible automated production lines. The production systems will be used to produce a wide variety of products with limited production quantities and quick turnaround requirements. The prototype system is designed to allow programming, process definition, fixture re-configuration, and process verification to be performed off-line for new products. CAD/CAM (Computer Aided Design/Computer Aided Manufacturing) models of the part will be used to assist with the automated process development and process control tasks. To achieve Sandia's performance goals, the system will be employ advanced path planning, burr prediction expert systems, automated process definition, statistical process models in a process database, and a two-level control scheme using hybrid position-force control and fuzzy logic control. In this paper, we discuss the progress and the planned system development under this project.

29949 (SAND–95-1547C) **Active control of bending vibrations in thick bars using PZT stack actuators.** Redmond, J.; Parker, G.; Barney, P.; Rodeman, R. Sandia National Labs., Albuquerque, NM (United States). [1995]. 5p. Sponsored by USDOE, Washington, DC (United States). DOE Contract AC04-94AL85000. (CONF-951135–11: International mechanical engineering congress and exhibition - winter annual meeting of the American Society of Mechanical Engineers, San Francisco, CA (United States), 12-17 Nov 1995). Order Number DE95015245. Source: OSTI; NTIS; GPO Dep.

An experimental investigation into active control of bending vibrations in thick bar and plate-like structural elements is described. This work is motivated by vibration problems in machine tools and photolithography machines that require greater control authority than available from conventional surface mounted PZT patches or PVDF films. Focus of this experiment is a cantilevered circular steel bar in which PZT stacks are mounted in cutouts near the bar root. Axially aligned and offset from the neutral axis, these actuators control the bending vibrations by generating moments in the bar through their compressive loads. A Positive Feedback control law is used to significantly augment the damping in the first bending mode. Implications of the experimental results for machine tool stability enhancement are discussed.

29950 (SAND–95-8688C) **Improving product quality and productivity using better guidelines for concept design.** Hinckley, C.M. (Sandia National Labs., Albuquerque, NM (United States)); Barkan, P. Sandia National Labs., Albuquerque, NM (United States). [1995]. 13p. Sponsored by USDOE, Washington, DC (United States). DOE Contract AC04-94AL85000. (CONF-9509210–1: Appliance manufactures conference and expo, Nashville, TN (United States), 26-27 Sep 1995). Order Number DE95016388. Source: OSTI; NTIS; GPO Dep.

The remarkable effectiveness of Japanese practices has led to a growing interest in the US in the development and application of rules and methodologies which attempt to capture design experience. US companies have found unexpected benefits and pitfalls in the application of these rules and methods. In this article, the authors critically examine one of the most widely accepted rules of Design for Manufacturability (DFM): minimize the number of parts. An examination of 240 assemblies and subassemblies has shown that rigid adherence to this rule can lead to unnecessarily complex parts and assembly. Quantitative insights derived from this study have led to a better design goal: minimize and simplify assembly operations. This new rule, which should not be rigidly interpreted, tends to reduce part count, while having the benefit of assuring improved assembly. Another significant advantage of the new design rule is that it results in lower product defect rates as demonstrated by correlations observed for a wide range of products from two different manufacturers. This research links quality to the product concept, enabling a new approach to improving quality at the earliest stages of design.

29951 (UCRL-ID–114972-2, pp. 11, Paper 7) **CAFE: Computer aided fabric evaluation.** Sims, J.E. Lawrence Livermore National Lab., CA (United States). 6 May 1994. (CONF-9405328–Absts.: Science and Engineering Research Semester (SERS) student symposium, Livermore, CA (United States), 6 May 1994). In *SERS intership: Spring 1994 abstracts and research papers*. 195p. Order Number DE95014118. Source: OSTI; NTIS; GPO Dep.

With the intent of automating the inspection of color printed fabrics for defects, the Engineering Research Division of the Lawrence Livermore National Laboratory in addition with several other national labs, in conjunction with the textile industry has initiated the CAFE project. The projects objective is predicated on the development, implementation and testing of an algorithm for the inspection of color printed fabrics. We attempt to take advantage of the wide ranging applications possible with Computer Vision in order to achieve this. The first job of the algorithm is to teach the computer the 'correct' repeat as the reference, tests the remaining repeats in the pattern. There are two different ways to go about doing the first job and with this paper we will describe both methods.

29952 (UCRL-ID–121182) **Waste acid recycling via diffusion dialysis.** Steffani, C. Lawrence Livermore National Lab., CA (United States). 26 May 1995. 8p. Sponsored by USDOE, Washington, DC (United States). DOE Contract W-7405-ENG-48. Order Number DE95017713. Source: OSTI; NTIS; GPO Dep.

Inorganic acids are commonly used for surface cleaning and finishing of metals. The acids become unuseable due to contamination with metals or diluted and weakened. Diffusion dialysis has become a way to recover the useable acid and allow separation of the metals for recovery and sale to refineries. This technique is made possible by the use of membranes that are strong enough to withstand low ph and have long service life.

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Refer also to citation(s) 29201, 29282, 29360, 29361, 29844, 29887

29953 (ES/WM–59) **Sludge application and monitoring program on the Oak Ridge Reservation, 1986 through 1993.** Gunderson, C.A.; Boston, H.L.; Van Miegroet, H., Morris, J.L.; Larsen, I.L.; Walzer, A.E.; Adler, T.C.; Bradburn, D.M.; Huq, M. Oak Ridge National Lab., TN (United States). Aug 1995. 110p. Sponsored by USDOE, Washington, DC (United States). DOE Contract AC05-84OR21400. Order Number DE95017312. Source: OSTI; NTIS; GPO Dep.

Municipal sewage sludge has been applied to forests and pastures on the DOE (U.S. Department of Energy) Oak Ridge Reservation (ORR) since 1983 as a method of both disposal and beneficial reuse. Application was carried out under State of Tennessee permits issued to the City of Oak Ridge for land disposal of. sewage sludge. In conjunction with these applications, information has been collected concerning sludge quantity and characteristics, soil parameters, soil water constituents, groundwater quality, surface runoff water quality, and various chemical constituents in vegetation on application sites. This information provides (1) a record of sludge application on the DOE ORR, and (2) documentation of changes in soil parameters following sludge application. The information also provides a basis for evaluating the implications of the land application of municipal sewage sludge for soil and water quality and for evaluating the fate of sludge constituents when sludge is either sprayed onto or injected into pasture sites or applied to the surface of forested sites. This report covers in detail sludge applications conducted from 1986 through 1993, with some data from the period between 1983 and 1986. Land application has been recommended by the U.S. Environmental Protection Agency as a desirable alternative for disposal of ORR waste. Municipal sewage sludge is in many ways similar to dilute animal manure fertilizer, but it also contains metals, organic chemicals, human pathogens, and other constituents reflective of inputs into the municipal sewage treatment plant. When applied to land, nutrients in the sludge improve soil fertility, and minerals and organic matter in the sludge improve soil structure. Under optimal conditions, metals are immobilized, and organic chemicals and pathogens are immobilized or destroyed. If the sludge is not managed effectively, however, sludge constituents have the potential to affect human health and the environment.

29954 (ETDE/CH-mf–95787322, pp. 69-72) **Fate of heavy metals during refuse incineration.** Wochele, J. (Paul Scherrer Inst. (PSI), Villigen (Switzerland)); Stucki, S. Paul Scherrer Inst. (PSI), Villigen (Switzerland). 1995. In *Paul Scherrer Institut annual report 1994. Annex V: PSI general energy technology newsletter 1994*. 123p. Source: OSTI; NTIS.

Thermodynamic equilibrium calculations for the combustion chemistry of typical Swiss municipal solid waste were carried out with a system of 19 elements and 514 species. Reducing and oxidizing atmospheres (λ=0.5, λ=1.5) were taken into consideration. Sulfides in the reducing and oxides in the oxidizing atmosphere are the stable solid forms of Hg, Cd, Zn, Pb, Cu, the heavy metals considered in this study. Hg, Cd and Zn volatilise preferably (i.e. at lower temperatures) in reducing atmosphere, whereas for Pb and Cu an oxygen rich atmosphere enhances evaporation. (author) figs., 1 tab., 5 refs.

29955 (ETDE/CH-mf–95787322, pp. 77-79) **Evaporation of heavy metals during the heat treatment of residues from municipal solid waste incineration.** Jakob, A. (Paul Scherrer Inst. (PSI), Villigen (Switzerland)); Stucki, S.; Kuhn, P. Paul Scherrer Inst. (PSI), Villigen (Switzerland). 1995. In *Paul Scherrer Institut annual report 1994. Annex V: PSI general energy technology newsletter 1994*. 123p. Source: OSTI; NTIS.

The thermal treatment is a promising way for the decontamination and inertization of filter ash from municipal solid waste incineration. The evaporation of heavy metals thereby is of great significance. The present work is focused on this problem. The evaporation of Zn, Pb, Cd and Cu turns out to be most effective at temperatures just below the melting range of the filter ash (i.e. at 1000-1100°C) and decreases drastically above this temperature range. At about 1100°C 98-100% of Pb, Cd, Cu and 50% of Zn can be evaporated by thermal treatment in air and 98-100% of Pb, Cd, Zn and 10% of Cu by thermal treatment in argon atmosphere, respectively. The decrease in the Zn evaporation at high temperatures is caused by the formation of Zn_2SiO_4. The results of the experiments in argon atmosphere are explained by the reductive potential of the carbon, contained in the residue. (author) 4 figs., 4 refs.

29956 (LBL–36647) **International DSM and DSM program evaluation: An INDEEP assessment.** Vine, E. Lawrence Berkeley Lab., CA (United States). Apr 1995. 23p. Sponsored by USDOE, Washington, DC (United States);Commission of the European Communities, Brussels (Belgium);Nederlandse Maatschappij voor

Energie en Milieu BV (NOVEM), Utrecht (Netherlands). DOE Contract AC03-76SF00098. (CONF-9506265–1: Summer study of the European Council for an Energy-Efficient Economy, Mandelieu (France), 6-10 Jun 1995). Order Number DE96000128. Source: OSTI; NTIS; GPO Dep.

This paper discusses the current level of demand-side management (DSM) occurring in selected European countries and reviews the availability of information on DSM programs and program evaluation. Next, thirteen European DSM programs are compared by examining such factors as: motivations for program implementation, marketing methods, participation rates, total energy savings, and program costs. The transfer of DSM program results and experiences found in these case studies is also discussed, as well as the lessons learned during the design, implementation, and evaluation of these programs. This paper represents a preliminary assessment of the state of DSM and DSM program evaluation in Europe. The findings from this work also represent the first steps in a joint international effort to compile and analyze the measured results of energy efficiency programs in a consistent and comprehensive fashion. The authors find that these programs represent cost-effective resources: the cost of energy saved by the programs ranged from a low of 0.0005 ECUs/kWh (0.01 ¢/kWh) to a high of 0.077 ECUs/kWh (9.7 ¢/kWh), with an average cost of 0.027 ECUs/kWh (3.3 ¢/kWh). Weighted by energy savings, the average cost of energy saved by the programs was 0.014 ECUs/kWh (1.8 ¢/kWh).

29957 (NREL/CP–200-8098, pp. 88-99) **An overview of waste-to-energy systems in the U.S.A.: Waste as an energy source.** Berenyi, E.B. (Governmental Advisory Associates, Inc., Westport, CT (United States)). National Renewable Energy Lab., Golden, CO (United States). [1995]. (CONF-9508104–: 2. meeting on biomass of the Americas, Portland, OR (United States), 21-24 Aug 1995). In *Second biomass conference of the Americas: Energy, environment, agriculture, and industry. Proceedings.* 1741p. Order Number DE95009230. Source: OSTI.

This paper examines biomass waste-to-energy in the United States. By far the largest source of biomass fuel is wood and wood wastes which accounts for 80% of biomass energy consumed in the United States. The next largest source is solid waste, which accounts for about 16% of biomass energy consumed. Within this source, municipal, commercial and industrial waste form the largest source of fuel in two ways: (a) burned as an actual fuel or processed, i.e. dried, pelletized and then burned, or (b) as a producer of methane gas in landfills. The gas is collected and processed to produce either a low to medium Btu fuel or cleaned to obtain pipeline quality natural gas. a few solid waste-to-energy plants are co-firing furnaces with sewage sludge; however, these types of facilities remain the rare exception. The overall reliance on biomass has increased somewhat over the last decade, particularly with respect to solid waste and wood. Landfill gas recovery is on the increase due to favorable regulations. In contrast, the number of waste-to-energy facilities drawing on waste from the commercial and municipal sectors are not expected to grow in the near future.

29958 (NREL/CP–200-8098, pp. 685-694) **Sewage sludge gasification: First studies.** Garcia-Bacaicoa, P. (Zaragoza Univ. (Spain)); Bilbao, R.; Uson, C. National Renewable Energy Lab., Golden, CO (United States). [1995]. Project 286-23. (CONF-9508104–: 2. meeting on biomass of the Americas, Portland, OR (United States), 21-24 Aug 1995). In *Second biomass conference of the Americas: Energy, environment, agriculture, and industry. Proceedings.* 1741p. Order Number DE95009230. Source: OSTI.

Wastewater treatment installations produce a large quantity of sewage sludge, the disposal and treatment of which causes several problems because of its volume, its toxic organic constituents and the heavy metals that it contains. Certain methods of treatment and disposal do exist, but they are not entirely satisfactory. Moreover, it is important to develop a technology for the adequate treatment of sewage sludge in order to reduce the environmental problem and the costs of treatment. It can be assumed that gasification is a suitable technology because it reduces the waste volume, destroys the toxic organic compounds and fixes the heavy metals in the resultant solid. In order to gain knowledge of the processes occurring in the gasifier, the results obtained in experiments on the thermal decomposition of sewage sludge at different heating rates are shown.

29959 (NREL/CP–200-8098, pp. 734-743) **Energy recovery from biosolids: The City of Los Angeles experience.** Haug, R.T. (Bureau of Engineering, Los Angeles, CA (United States)); Moore, G.L.; Harrison, D.S. National Renewable Energy Lab., Golden, CO (United States). [1995]. (CONF-9508104–: 2. meeting on biomass of the Americas, Portland, OR (United States), 21-24 Aug 1995). In *Second biomass conference of the Americas: Energy, environment, agriculture, and industry. Proceedings.* 1741p. Order Number DE95009230. Source: OSTI.

The City of Los Angeles' Hyperion Treatment Plant serves an area of 1,500 sq km (600 sq mi) with a contributory population of nearly 4 million. The plant currently produces more than 250 dry tonnes per day (dtpd) of digested, dewatered biosolids and is being expanded and upgraded to provide pure oxygen, full secondary treatment by 1998. The modern Hyperion Plant began operating in 1951. Since that time, Hyperion has provided anaerobic digestion for its biosolids and has used the produced biogas for power generation. In the 1980's the City completed a major expansion of its power generation and biosolids handling facilities at Hyperion. These facilities became known as the Hyperion Energy Recovery System (HERS) and their objective is to maximize the recovery of energy from the renewable biosolids. Today, these facilities are operational and continue to be modified to optimize performance and expanded to meet the increased loadings from full secondary treatment. Biogas produced by the anaerobic digestion process is compressed, scrubbed to remove H_2S, and used to power a gas turbine, combined cycle cogeneration system. Emergency flares are provided in the event of a power plant outage. A portion of the biosolids are transported offsite for beneficial reuse, such as composting and direct land application. The remaining solids are centrifugally dewatered and dried by indirect rotary dryers to produce about 50 dtpd of dried biofuel. Biofuel produced from the drying processes is fired in a fluidized bed gasification and staged combustion process (FBC) designed to recover energy and reduce air emissions. Superheated steam is produced in a waste heat boiler and converted to electrical power is a condensing steam turbine. Bioash from the FBC's is contracted for off-site reuse, primarily as a fluxing agent in copper smelting and as a source of silica, aluminum, iron and calcium for manufacture of portland cement.

29960 (NREL/CP–200-8098, pp. 744-752) **Commercial operating experience with the Valorga process in the municipal solid waste treatment field.** Saint-Joly, C. (Valorga Process, Vendargues (France)); Morris, S.A. National Renewable Energy Lab., Golden, CO (United States). [1995]. (CONF-9508104–: 2. meeting on biomass of the Americas, Portland, OR (United States), 21-24 Aug 1995). In *Second biomass conference of the Americas: Energy, environment, agriculture, and industry. Proceedings.* 1741p. Order Number DE95009230. Source: OSTI.

The Valorga Process is an anaerobic digestion process that has been developed for municipal solid wastes. Commercial plants have been operated with good results for several years. Start-up of the latest plant to be built (Tilburg Plant) occurred in January 1994. Operating results are reviewed.

29961 (NREL/CP–200-8098, pp. 753-763) **Animal manure digestion systems in central Europe.** Koeberle, E. (Fachverband Biogas e. V., Obermarchtat (Germany)). National Renewable Energy Lab., Golden, CO (United States). [1995]. (CONF-9508104–: 2. meeting on biomass of the Americas, Portland, OR (United States), 21-24 Aug 1995). In *Second biomass conference of the Americas: Energy, environment, agriculture, and industry. Proceedings.* 1741p. Order Number DE95009230. Source: OSTI.

This work provides an overview of existing plants in Europe and describes the substrates being used. It focuses on the individual farm-scale and community plants, as these are the two main types now being built. It also describes plants currently under construction, especially in Germany and Denmark, where the major efforts are focused. A description of how the technique has developed over the past few years, its current state of development, the motivation and economic balance, and the substrate characteristics, is presented.

29962 (NREL/CP–200-8098, pp. 764-773) **The AgSTAR program: Its second year.** Lehnertz, C.S. (EPA, Washington, DC

(United States)); Roos, K.F.; Moffitt, D.C. National Renewable Energy Lab., Golden, CO (United States). [1995]. (CONF-9508104–: 2. meeting on biomass of the Americas, Portland, OR (United States), 21-24 Aug 1995). In *Second biomass conference of the Americas: Energy, environment, agriculture, and industry. Proceedings.* 1741p. Order Number DE95009230. Source: OSTI.

AgSTAR, a voluntary pollution prevention program for agriculture, is sponsored by the U.S. Environmental Protection Agency (EPA), U.S. Department of Agriculture's Natural Resources Conservation Service (NRCS) and U.S. Department of Energy (DOE), under President Clinton's Climate Change Action Plan. The program encourages the recovery and utilization of methane gas captured from livestock manure, resulting in strong financial returns for livestock producers, in the form of on-site energy offsets. By investing in methane recovery technologies, AgSTAR participants realize substantial returns through (1) reduced electric, gas and oil bills; (2) revenues from high quality manure byproducts; and (3) savings on manure management operational costs. The environment realizes benefits through the reduction of methane emissions to the atmosphere, reduction of odors, and improved water quality. While methane recovery for on-farm energy production has been implemented to a limited extent in the U.S., a number of information, technical and financial barriers have limited widespread use of the technology. AgSTAR is strategically designed to break through each of these barriers. After a productive first year of developing products, information and services to assist the livestock producer, AgStar is ready to roll out the program in the second year. This paper summarizes AgSTAR's early successes, including development of national biogas design and construction standards, an on-farm decision support software called FarmWare, AgSTAR Charter Farms, and other services and products.

29963 (NREL/CP–200-8098, pp. 774-784) **Turning a liability into an asset: Developing a landfill gas energy recovery project.** Kerr, T.M. (EPA, Washington, DC (United States)). National Renewable Energy Lab., Golden, CO (United States). [1995]. (CONF-9508104–: 2. meeting on biomass of the Americas, Portland, OR (United States), 21-24 Aug 1995). In *Second biomass conference of the Americas: Energy, environment, agriculture, and industry. Proceedings.* 1741p. Order Number DE95009230. Source: OSTI.

Landfill methane is a potent greenhouse gas and a renewable fuel that can be harvested and put to use to meet diverse energy needs. Landfill energy recovery is a proven technology; over 120 sites in the United States alone convert landfill gas to energy. EPA estimates that as many as 750 landfills in the U.S. could cost-effectively recover energy from landfill gas; however, landfills must be individually assessed to determine whether an energy recovery project is feasible. Necessary elements of a feasibility assessment include: determining whether an energy recovery project is feasible for a particular landfill; determining what type of energy recovery project is right for a particular landfill (e.g., electricity generation; upgrade to pipeline quality gas; direct use of processed gas; and in emerging technologies, such as compression for vehicle fuel, conversion to methanol, fuel cells); evaluating project economics, including an evaluation of project costs and available incentives; and assessing other issues, such as assessing options for financing, selecting a project development partner, negotiating an energy sales contract with an electrical utility and permitting. The EPA's Landfill Methane Outreach Program (LMOP) encourages the development of landfill energy recovery projects. The LMOP is environmentally beneficial, in that it promotes projects which cause a measurable reduction in methane; as well as economical-energy recovery projects have proven to be profitable investments. The LMOP is uniquely able to work with all of the stakeholders, including municipal solid waste landfill owners and operators, states, utilities, the landfill energy recovery industry, and the financial community, to effectively overcome barriers to landfill energy recovery project development.

29964 (NREL/CP–200-8098, pp. 801-808) **Anaerobic digestion of municipal solid waste: Technical developments.** Rivard, C.J. (National Renewable Energy Lab., Golden, CO (United States)). National Renewable Energy Lab., Golden, CO (United States). [1995]. (CONF-9508104–: 2. meeting on biomass of the Americas, Portland, OR (United States), 21-24 Aug 1995). In *Second biomass conference of the Americas: Energy, environment, agriculture, and industry. Proceedings.* 1741p. Order Number DE95009230. Source: OSTI.

The anaerobic biogasification of organic wastes generates two useful products: a medium-Btu fuel gas and a compost-quality organic residue. Although commercial-scale digestion systems are used to treat municipal sewage wastes, the disposal of solid organic wastes, including municipal solid wastes (MSW), requires a more cost-efficient process. Modern biogasification systems employ high-rate, high-solids fermentation methods to improve process efficiency and reduce capital costs. The design criteria and development stages are discussed. These systems are also compared with conventional low-solids fermentation technology.

29965 (ORNL/TM–11601) **Sludge application and monitoring program on the Oak Ridge Reservation, 1986–1993.** Gunderson, C.A. (Oak Ridge National Lab., TN (United States)); Larsen, I.L.; Boston, H.L.; Bradburn, D.M.; Van Miegroet, H.; Morris, J.L.; Walzer, A.E.; Adler, T.C. Oak Ridge National Lab., TN (United States). Sep 1995. 140p. Sponsored by USDOE, Washington, DC (United States). DOE Contract AC05-84OR21400. Order Number DE95017849. Source: OSTI; NTIS; INIS; GPO Dep.

Environmental Sciences Division publication number 4445.

Municipal sewage sludge has been applied to forests and pastures on the Oak Ridge Reservation since 1983 as a method of both disposal and beneficial reuse. Application was carried out under Tennessee permits issued to the city of Oak Ridge for land disposal of sewage sludge. In conjunction with these applications, information has been collected concerning sludge quantity and characteristics, soil parameters, soil water constituents, groundwater quality, surface runoff water quality, and various chemical constituents in vegetation on application sites. This information provides (1) a record of sludge application on the DOE reservations and (2) documentation of changes in soil parameters following sludge application. The information also provides a basis for evaluating the implications of the land application of municipal sewage sludge for soil and water quality and for evaluating the fate of sludge constituents when sludge is either sprayed or injected on pasture sites or surface applied in forested sites. This report covers in detail sludge applications conducted from 1986 through 1993, with some data from the period between 1983 and 1986. Anaerobically digested liquid sludge (2% to 4% solids) from the city of Oak Ridge had a relatively high nitrogen content (8% dry weight) and average to low concentrations of potentially problematic metals, compared with typical municipal sludges. Few potentially hazardous organic chemicals were detected in the sludge, and when found, these were at very low concentrations. Oak Ridge sludge is somewhat unique in that it contains radionuclides (^{137}Cs, ^{60}Co, ^{131}I, uranium isotopes, ^{90}Sr, and occasionally ^{99}Tc) at concentrations much higher than typical municipal sludges. Land application of sewage sludge can dilute or destroy problematic sludge constituents while improving soil fertility. Correct management has made these sludge applications a model of environmentally responsible waste management.

29966 (SAND–94-3143) **Renewable energy load assessment for Boquillas Del Carmen Coahuila, Mexico.** Foster, R. (Southwest Technology Development Institute, Las Cruces, NM (United States)). Sandia National Labs., Albuquerque, NM (United States). Aug 1995. 60p. Sponsored by USDOE, Washington, DC (United States). DOE Contract AC04-94AL85000. Order Number DE96001364. Source: OSTI; NTIS; GPO Dep.

This report outlines the estimates that were made in 1992 of the potential load requirements for Boquillas del Carmen, a small Mexican village on the northern border of the state of Coahuila, Mexico near Big Bend National Park in southern Texas. The study was made to help determine the possibility that village might be electrified by solar or wind energy. Various estimates of are given of the potential load based on estimates ranging from basic use of lights, radio, television, and small household appliances to microwave ovens, refrigerators, and direct evaporative coolers. The low-energy consumption case was estimated to be at 23.0 kWh/month per residence per month, and the high-energy consumption case

(with cooling) was 140.7 kWh/month per residence. On average, the typical residence is occupied by five individuals.

29967 (UCRL-ID–114972-2, pp. 11, Paper 5) **Hydrogen production by gasification of municipal solid waste.** Robers, R. Lawrence Livermore National Lab., CA (United States). 6 May 1994. (CONF-9405328–Absts.: Science and Engineering Research Semester (SERS) student symposium, Livermore, CA (United States), 6 May 1994). In *SERS intership: Spring 1994 abstracts and research papers.* 195p. Order Number DE95014118. Source: OSTI; NTIS; GPO Dep.

As fossil fuel reserves run lower and lower, and as their continued widespread use leads toward numerous environmental problems, the need for clean and sustainable energy alternatives becomes ever clearer. Hydrogen fuel holds promise as such an energy source, as it burns cleanly and can be extracted from a number of renewable materials such as municipal solid waste (MSW), which is considered to be largely renewable because of its high content of paper and biomass-derived products. A computer model is being developed using Aspen Plus™ flowsheeting software to simulate a process which produces hydrogen gas from MSW; the model will later be used in studying the economics of this process and is based on an actual Texaco coal gasification plant design.

29968 (UCRL-ID–119685) **Process modeling of hydrothermal treatment of municipal solid waste to form high solids slurries in a pilot scale system.** Thorsness, C.B. Lawrence Livermore National Lab., CA (United States). 16 Feb 1995. 66p. Sponsored by USDOE, Washington, DC (United States). DOE Contract W-7405-ENG-48. Order Number DE95017043. Source: OSTI; NTIS; GPO Dep.

Two models are developed for characterizing the hydrothermal decomposition of municipal solid waste (MSW) in a pilot scale facility. The process modeled involves the use of high pressure steam to directly heat surrogate MSW, newspaper, to temperatures and pressures where decomposition reactions breakdown the organic matter to form a coal like solid having properties which make it suitable as a feedstock for a commercial gasifier. One model uses the ASPEN steady-state simulator. This model is only capable of computing a limited number of process variables. To more adequately deal with the transient behavior of the inherently batch process a second transient model is formulated. The model allows important process temperatures, pressures, gas flows and compositions to be calculated as a function of time. The model has been used to scope possible operating scenarios for proposed pilot scale experiments and these results are presented. Based on computed results a recommendation is made that the first pilot experiment use a dampened feed material containing a water-to-dry newspaper ratio of 0.5 to 1. The transient model predicts that this will result in a slurry product in the reactor vessel after cooldown containing 57 wt.% water.

33 ADVANCED PROPULSION SYSTEMS

Refer also to citation(s) 30032

3301 Internal Combustion Engines

Refer also to citation(s) 29429, 29978

29969 (NREL/CP–433-7748, pp. 250-267) **Continuous diesel emissions speciation with a transportable MBMS system.** Ratcliff, M.A. (National Renewable Energy Lab., Golden, CO (United States)); Gratson, D.A.; Milne, T.A. National Renewable Energy Lab., Golden, CO (United States). Mar 1995. (CONF-9410343–: Applications of free-jet, molecular beam, mass spectrometric sampling conference, Estes Park, CO (United States), 11-14 Oct 1994). In *Applications of free-jet, molecular beam, mass spectrometric sampling: Proceedings.* 305p. Order Number DE95004052. Source: OSTI; NTIS; GPO Dep.

A unique transportable molecular beam mass spectrometer (TMBMS) has been developed at the National Renewable Energy Laboratory (NREL) to extend the virtues of MBMS analysis to new applications beyond the traditional laboratory scope and scale. The TMBMS is based on a three stage vacuum system; the transport capability dictated the minimization of size. weight and required utilities. The instrument has demonstrated a dynamic range of at least 10^6 and a limit of detection of 0.5 ppmv, depending on the species and system being investigated. The instrument has been successfully used as a continuous emissions monitor and a chemical process monitor. Continuous, near real-time speciation of diesel exhaust demonstrated the potential of MBMS analysis in the field of emissions monitoring. Controlled steady state and transient tests were conducted with conventional diesel and soybean derived methyl-ester biodiesel fuels. The emissions differences between the two fuels were readily apparent, with the diesel fuel producing higher concentrations of hydrocarbon species. It was statistically demonstrated that many unburned diesel fuel hydrocarbons can be reproducibly detected and followed under a variety of steady state conditions. Carbon dioxide, water, nitric oxide and sulfur dioxide were monitored simultaneously with the unburned hydrocarbons. The transient testing demonstrated the instruments ability to follow changes, on the seconds time scale, of multiple combustion products as a function of engine speed, load and throttle position.

29970 (ORNL–6874, pp. 35-43) **Development of microwave-heated diesel particulate filters.** Janney, M.A. (Oak Ridge National Lab., TN (United States)); Stinton, D.P. Oak Ridge National Lab., TN (United States). Jun 1995. DOE Contract AC05-84OR21400. In *Fossil Energy Program annual progress report for April 1994 through March 1995.* 203p. Order Number DE95015441. Source: OSTI; NTIS; GPO Dep.

Ceramic fiber filters are being fabricated and tested for use as diesel particulate filters. The filters are to be heated by microwave energy to remove carbon and regenerate the filters.

3303 Electric-Powered Systems

Refer also to citation(s) 29190, 29980

29971 (GAO/PEMD–95-7) **Electric vehicles: Likely consequences of US and other nations' programs and policies.** Chan, Kwai-Cheung. General Accounting Office, Washington, DC (United States). 30 Dec 1994. 138p. Sponsored by General Accounting Office, Washington, DC (United States). Source: OSTI; U.S. General Accounting Office, P.O. Box 6015, Gaithersburg, MD 20884-6015 (United States); (phone) 202-512-6000; (fax) 301-258-4066; (TDD) 301-413-0006.

This report examines international electric vehicle development and commercialization programs. The study encompassed a review of current barriers to widespread electric vehicle implementation, field visits in seven nations and the United States to examine electric vehicle programs and policies, and analyses of electric vehicle effects on economics, energy, and the environment.

29972 (INEL–95/0309) **Electric and hybrid vehicle program site operator program. Quarterly progress report, October 1994–December 1994 (First quarter of FY-95).** Kiser, D.M.; Brown, H.L. EG and G Idaho, Inc., Idaho Falls, ID (United States). Jul 1995. 40p. Sponsored by USDOE, Washington, DC (United States). DOE Contract AC07-94ID13223. Order Number DE96001372. Source: OSTI; NTIS; GPO Dep.

The DOE Site Operator Program was initially established to meet the requirements of the Electric and Hybrid Vehicle Research, Development, and Demonstration Act of 1976. The Program has since evolved in response to new legislation and interests. Its mission now includes three ma or activity categories: (1) Advancement of Electric Vehicle (EV) technologies, (2) Development of infrastructure elements needed to support significant EV use, and (3) Increasing public awareness and acceptance of EVs. The 13 Program participants, their geographic locations, and the principal thrusts of their efforts are identified in Table ES-1. The EV inventories of each participant are summarized in Table ES-2.

3304 Hybrid Systems

Refer also to citation(s) 29972

29973 (CONF-9406355–Absts.) **Hybrid electric vehicles TOPTEC.** Society of Automotive Engineers, Inc., Warrendale, PA

(United States). 21 Jun 1994. 100p. Sponsored by USDOE, Washington, DC (United States). DOE Contract FG02-94CE50388. From Society of Automotive Engineers (SAE) in the 90's: hybrid electric vehicles TOPTEC workshop; Southfield, MI (United States); 21 Jun 1994. Order Number DE96001032. Source: OSTI; NTIS; GPO Dep.

This one-day TOPTEC session began with an overview of hybrid electric vehicle technology. Updates were given on alternative types of energy storage, APU control for low emissions, simulation programs, and industry and government activities. The keynote speech was about battery technology, a key element to the success of hybrids. The TOPEC concluded with a panel discussion on the mission of hybrid electric vehicles, with a perspective from industry and government experts from United States and Canada on their view of the role of this technology.

29974 (UCRL-JC–120325) **Series hybrid vehicles and optimized hydrogen engine design.** Smith, J.R. (Lawrence Livermore National Lab., CA (United States)); Aceves, S.; Van Blarigan, P. Lawrence Livermore National Lab., CA (United States). 10 May 1995. 21p. Sponsored by USDOE, Washington, DC (United States). DOE Contract W-7405-ENG-48. (CONF-950857–4: Society of Automotive Engineers future transportation technology conference and exposition, Costa Mesa, CA (United States), 7-10 Aug 1995). Order Number DE95017816. Source: OSTI; NTIS; GPO Dep.

Lawrence Livermore, Sandia Livermore and Los Alamos National Laboratories have a joint project to develop an optimized hydrogen fueled engine for series hybrid automobiles. The major divisions of responsibility are: system analysis, engine design and kinetics modeling by LLNL; performance and emission testing, and friction reduction by SNL; computational fluid mechanics and combustion modeling by LANL. This project is a component of the Department of Energy, Office of Utility Technology, National Hydrogen Program. We report here on the progress on system analysis and preliminary engine testing. We have done system studies of series hybrid automobiles that approach the PNGV design goal of 34 km/liter (80 mpg), for 384 km (240 mi) and 608 km (380 mi) ranges. Our results indicate that such a vehicle appears feasible using an optimized hydrogen engine. The impact of various on-board storage options on fuel economy are evaluated. Experiments with an available engine at the Sandia Combustion Research Facility demonstrated NO_x emissions of 10 to 20 ppm at an equivalence ratio of 0.4, rising to about 500 ppm at 0.5 equivalence ratio using neat hydrogen. Hybrid vehicle simulation studies indicate that exhaust NO_x concentrations must be less than 180 ppm to meet the 0.2 g/mile California Air Resources Board ULEV or Federal Tier II emissions regulations. We have designed and fabricated a first generation optimized hydrogen engine head for use on an existing single cylinder Onan engine. This head currently features 14.8:1 compression ratio, dual ignition, water cooling, two valves and open quiescent combustion chamber to minimize heat transfer losses.

3306 Vehicle Design Factors

Refer also to citation(s) 30081, 31379

29975 (LA-UR–95-855) **Robust controller design of four wheel steering systems using mu synthesis techniques.** Gao, X.; McVey, B.D.; Tokar, R.L. Los Alamos National Lab., NM (United States). 27 Feb 1995. 25p. Sponsored by USDOE, Washington, DC (United States). DOE Contract W-7405-ENG-36. (CONF-951206–1: 34. IEEE conference on decision and control, New Orleans, LA (United States), 13-15 Dec 1995). Order Number DE95009432. Source: OSTI; NTIS; GPO Dep.

In this paper, a linearized four wheel steering (4WS) system model is deduced and then modified into a form which is appropriate for applying Matlab μ Toolbox to design robust controller. Several important topics are discussed in detail, such as (1) how to make system set-up match Matlab μ Toolbox requirement, (2) how to select weights based on plant's uncertainty, (3) how to solve controller discretization problem, and (4) how to adjust the system so that the conditions necessary for using a state-space formula to solve H_∞ optimal (sub-optimal) problem and performing the Matlab μ Toolbox D–K iteration procedure are satisfied. Finally simulation results of robust controller and a PID controller are compared.

3307 Emission Control

Refer also to citation(s) 28655

29976 (NYSERDA–95-11) **Zero-emission vehicle technology assessment. Final report.** Woods, T. New York State Energy Research and Development Authority, New York, NY (United States); Booz, Allen and Hamilton, Inc., McLean, VA (United States). Aug 1995. 150p. Sponsored by New York State Energy Research and Development Authority, Albany, NY (United States). Source: OSTI; New York State Energy Research and Development Authority, Two Empire State Plaza, Suite 1901, Albany, NY 12223-1253 (United States); New York State Energy Research and Development Authority, 2 Empire State Plaza, Suite 1901, Albany, NY 12223-1253 (United States). Phone: 518-465-6251, extension 241.

This is the final report in the Zero-Emission Vehicle (ZEV) Technology Assessment, performed for NYSERDA by Booz-Allen & Hamilton Inc. Booz-Allen wrote the final report, and performed the following tasks as part of the assessment: assembled a database of key ZEV organizations, their products or services, and plans; described the current state of ZEV technologies; identified barriers to widespread ZEV deployment and projected future ZEV technical capabilities; and estimated the cost of ZEVs from 1998 to 2004. Data for the ZEV Technology Assessment were obtained from several sources, including the following: existing ZEV industry publications and Booz-Allen files; major automotive original equipment manufacturers; independent electric vehicle manufacturers; battery developers and manufacturers; infrastructure and component developers and manufacturers; the U.S. Department of Energy, the California Air Resources Board, and other concerned government agencies; trade associations such as the Electric Power Research Institute and the Electric Transportation Coalition; and public and private consortia. These sources were contacted by phone, mail, or in person. Some site visits of manufacturers also were conducted. Where possible, raw data were analyzed by Booz-Allen staff and/or verified by independent sources. Performance data from standardized test cycles were used as much as possible.

29977 (UCRL-ID–114972-2, pp. 12, Paper 11) **Nonthermal plasma reactors for treatment of NO_x and other hazardous gas emissions.** Thomas, D.S. (Univ. of Illinois, Urbana-Champaign, IL (United States)). Lawrence Livermore National Lab., CA (United States). 6 May 1994. (CONF-9405328–Absts.: Science and Engineering Research Semester (SERS) student symposium, Livermore, CA (United States), 6 May 1994). In *SERS intership: Spring 1994 abstracts and research papers.* 195p. Order Number DE95014118. Source: OSTI; NTIS; GPO Dep.

The 1990 Clean Air Act Amendments passed by the United States government has prompted a great deal of interest in reducing the amount of hazardous pollutants released into the air. Of particular interest to Lawrence Livermore National Laboratory is the reduction of NO_x produced by mobile diesel engines. The use of nonthermal plasma technologies is employed in the effort to reduce the amount of toxins present in diesel exhaust.

3308 Alternative Fuels

Refer also to citation(s) 28760, 29263, 29265, 29284, 29285, 29286, 29302, 29303, 29304, 29305, 29306, 29307, 29308

29978 (NREL/TP–425-6969) **Alternative-fueled truck demonstration natural gas program: Caterpillar G3406LE development and demonstration.** National Renewable Energy Lab., Golden, CO (United States); Acurex Environmental Corp., Mountain View, CA (United States). Jun 1995. 100p. Sponsored by USDOE, Washington, DC (United States). DOE Contract AC36-83CH10093. Order Number DE95009233. Source: OSTI; NTIS; GPO Dep.

In 1990, the California Energy Commission, the South Coast Air Quality Management District, and the Southern California Gas Company joined together to sponsor the development and demonstration of compressed natural gas engines for Class 8 heavy-duty line-haul trucking applications. This program became part of an overall Alternative-Fueled Truck Demonstration Program, with the goal of advancing the technological development of alternative-fueled engines. The demonstration showed natural gas to be a technically viable fuel for Class 8 truck engines.

29979 (NREL/TP–425-7619) **Alternative fuel transit buses: Interim results from the National Renewable Energy Laboratory (NREL) Vehicle Evaluation Program.** Motta, R.; Norton, P.; Kelly, K.J.; Chandler, K. National Renewable Energy Lab., Golden, CO (United States). May 1995. 21p. Sponsored by USDOE, Washington, DC (United States). DOE Contract AC36-83CH10093. Order Number DE95013115. Source: OSTI; NTIS; GPO Dep.

The transit bus program is designed to provide a comprehensive study of the alternative fuels currently used by the transit bus industry. The study focuses on the reliability, fuel economy, operating costs, and emissions of vehicles running on the various fuels and alternative fuel engines. The alternative fuels being tested are methanol, ethanol, biodiesel and natural gas. The alternative fuel buses in this program use the most common alternative fuel engines from the heavy-duty engine manufacturers. Data are collected in four categories: Bus and route descriptions; Bus operating data; Emissions data; and, Capital costs. The goal is to collect 18 months of data on each test bus. This report summarizes the interim results from the project to date. The report addresses performance and reliability, fuel economy, costs, and emissions of the busses in the program.

29980 (UCRL-JC–121355) **Hydrogen as a near-term transportation fuel.** Schock, R.N.; Berry, G.D.; Smith, J.R.; Rambach, G.D. Lawrence Livermore National Lab., CA (United States). 29 Jun 1995. 9p. Sponsored by USDOE, Washington, DC (United States). DOE Contract W-7405-ENG-48. (CONF-951161–1: International symposium on energy environment economics, Melbourne (Australia), 20-24 Nov 1995). Order Number DE95015907. Source: OSTI; NTIS; GPO Dep.

The health costs associated with urban air pollution are a growing problem faced by all societies. Automobiles burning gasoline and diesel contribute a great deal to this problem. The cost to the United States of imported oil is more than US$50 billion annually. Economic alternatives are being actively sought. Hydrogen fuel, used in an internal combustion engine optimized for maximum efficiency and as part of a hybrid-electric vehicle, will give excellent performance and range (>480 km) with emissions well below the ultra-low emission vehicle standards being required in California. These vehicles can also be manufactured without excessive cost. Hydrogen-fueled engines have demonstrated indicated efficiencies of more than 50% under lean operation. Combining engine and other component efficiencies, the overall vehicle efficiency should be about 40%, compared with 13% for a conventional vehicle in the urban driving cycle. The optimized engine-generator unit is the mechanical equivalent of the fuel cell but at a cost competitive with today's engines. The increased efficiency of hybrid-electric vehicles now makes hydrogen fuel competitive with today's conventional vehicles. Conservative analysis of the infrastructure options to support a transition to a hydrogen-fueled light-duty fleet indicates that hydrogen may be utilized at a total cost comparable to what US vehicle operators pay today. Both on-site production by electrolysis or reforming of natural gas and liquid hydrogen distribution offer the possibility of a smooth transition by taking advantage of existing low-cost, large-scale energy infrastructures. Eventually, renewable sources of electricity and scalable methods of making hydrogen will have lower costs than today. With a hybrid-electric propulsion system, the infrastructure to supply hydrogen and the vehicles to use it can be developed today and thus can be in place when fuel cells become economical for vehicle use.

35 ARMS CONTROL

Refer also to citation(s) 29150

3501 Policy, Negotiations, and Legislation

Refer also to citation(s) 29989

29981 (LA-UR–95-3095) **Environmental sampling: Issues for the cut-off regime.** Fearey, B.L. Los Alamos National Lab., NM (United States). [1995]. 6p. Sponsored by USDOE, Washington, DC (United States). DOE Contract W-7405-ENG-36. (CONF-9508162–1: Fillile material cut-off treaty non-routine inspection workshop, Washington, DC (United States), 29 Aug 1995). Order Number DE96000048. Source: OSTI; NTIS; INIS; GPO Dep.

The fissile material cut-off treaty (FMCT) initiative under the Conference on Disarmament mandate is envisioned to include certain aspects of environmental sampling and monitoring. One of the intents of this treaty is to bring certain non-NPT signatories (e.g., threshold states) under this treaty agreement along with the nuclear weapon states (NWSs). This paper provides a brief overview of some of the relevant issues that may be involved in the implementation and use of environmental monitoring for (1) verification of the cut-off regime declarations, (2) the detection of undeclared activities, and, (3) application in non-routine inspections. The intent is to provide backstopping information important for treaty negotiators. Specific issues addressed within this paper include signature sampling, differences in the proposed detection regime, potential signature integrators, specific examples and spoofing concerns. Many of these issues must be carefully considered and weighed in order to create a credibly verifiable inspection regime. Importantly, the cut-off treaty must enable nondiscriminatory implementation, while carefully assuring that nonproliferation treaty requirements are maintained (i.e., preventing unintentional release of critical weapons design information–potentially through environmental sampling and analysis).

29982 (SAND–95-1650C) **Cooperative monitoring of regional security agreements.** Pregenzer, A.L.; Vannoni, M.; Biringer, K.L. Sandia National Labs., Albuquerque, NM (United States). [1995]. 27p. Sponsored by USDOE, Washington, DC (United States). DOE Contract AC04-94AL85000. (CONF-9506254–1: ROK-Canada arms control workshop, Seoul (Korea, Republic of), 7-9 Jun 1995). Order Number DE95015539. Source: OSTI; NTIS; GPO Dep.

This paper argues that cooperative monitoring plays a critical role in the implementation of regional security agreements and confidence building measures. A framework for developing cooperative monitoring options is proposed and several possibilities for relating bilateral and regional monitoring systems to international monitoring systems are discussed. Three bilateral or regional agreements are analyzed briefly to illustrate different possibilities: (1) the demilitarization of the Sinai region between Israel and Egypt in the 1970s; (2) the 1991 quadripartite agreement for monitoring nuclear facilities among Brazil, Argentina, The Argentine-Brazilian Agency for Accounting and Control of Nuclear Materials and the International Atomic Energy Agency; and (3) a bilateral Open Skies agreement between Hungary and Romania in 1991. These examples illustrate that the relationship of regional or bilateral arms control or security agreements to international agreements depends on a number of factors: the overlap of provisions between regional and international agreements; the degree of interest in a regional agreement among the international community; efficiency in implementing the agreement; and numerous political considerations.Given the importance of regional security to the international community, regions should be encouraged to develop their own infrastructure for implementing regional arms control and other security agreements. A regional infrastructure need not preclude participation in an international regime. On the contrary, establishing regional institutions for arms control and nonproliferation could result in more proactive participation of regional parties in developing solutions for regional and international problems, thereby strengthening existing and future international regimes. Possible first steps for strengthening regional infrastructures are identified and potential technical requirements are discussed.

3502 Proliferation

Refer also to citation(s) 29139, 29149

29983 (LA-UR–95-2333) **A systems framework for nonproliferation research and development.** Olinger, C.T.; Voss, S.S. Los Alamos National Lab., NM (United States). [1995]. 8p. Sponsored by USDOE, Washington, DC (United States). DOE Contract W-7405-ENG-36. (CONF-950787–63: 36. annual meeting of the Institute for Nuclear Materials Management, Palm Desert, CA (United

States), 9-12 Jul 1995). Order Number DE95016784. Source: OSTI; NTIS; GPO Dep.

International safeguards and nonproliferation regimes are currently in a state of rapid flux. Changes in the scope of nonproliferation activities over the next few years will likely bring an overall larger fraction of the world's nuclear material under some form of international inspection. Without a commensurate increase in resources, the unintended net effect of this could conceivably reduce overall international safeguards effectiveness. One possible solution is to increase available fiscal resources, but this may be unrealistic considering the current political climate. Alternatively, technological advances and hard political decisions can help to increase the effectiveness of nonproliferation resources. The purpose of this study is to evaluate the many nonproliferation drivers to determine how to be proactive in a changing political environment.

3503 Verification

Refer also to citation(s) 29981, 29982, 30575, 30616, 30618, 30620, 30621, 31381

29984 (BNL–52477) **Development of a cable reel development system using a rotary joint for kilometer lengths of two-fiber multi-mode fiber optic cable.** Curtiss, J.A.; Jahelka, J.R. Brookhaven National Lab., Upton, NY (United States). 11 Aug 1995. 50p. Sponsored by USDOE, Washington, DC (United States);Defense Nuclear Agency, Washington, DC (United States). DOE Contract AC02-76CH00016. (SSN–95-26). Order Number DE95017555. Source: OSTI; NTIS; GPO Dep.

Brookhaven National Laboratory (BNL) recently developed a two-component system for use during remote inspections. The system consists of a mobile unit with television cameras and other equipment and a stationary base station. A variety of signals must be continually transmitted between the two system components as the mobile unit is moved from the location to another. Two channels of broadband (10MHz) NTSC video are transmitted from the mobile unit to the base station, and a bi-directional "talk set" provides audio communication between personnel at each location. In addition, several channels of RS-232 are required to support present and future instruments used at the mobile unit and controlled by personnel at the base station. Brookhaven developed a mobile unit which communicated with a base station over a 2-fiber multimode fiber optic cable. One of the design requirements was maintaining constant communication with the base station during the time the mobile unit was moved about. To provide uninterrupted communications, deployment of the 1-km long fiber optic cable was initially performed with a "spinning reel" mechanism. The spinning reel mechanism proved to be mechanically unsuitable, and so the cable deployment mechanism was redesigned to spool the cable off the reel. The requirement for uninterrupted communications required a two-channel fiber optic rotary joint in the design. Incorporation of the rotary joint into the design is described, and appropriate reference material is included.

29985 (LA-UR–95-2698) **Practical observations of US mining practices and implications for CTBT monitoring.** Stump, B.W. Los Alamos National Lab., NM (United States). [1995]. 10p. Sponsored by USDOE, Washington, DC (United States). DOE Contract W-7405-ENG-36. (CONF-9509211–2: 17. annual seismic research symposium on monitoring a comprehensive test ban treaty, Scottsdale, AZ (United States), 11-15 Sep 1995). Order Number DE95016945. Source: OSTI; NTIS; GPO Dep.

Man made and man induced seismic events associated with surface and underground mining operations produce seismic signals that might have to be identified when monitoring a Comprehensive Test Ban Treaty (CTBT). The importance of these sources to the monitoring process depend on the size of the seismic signal they generate and the degree of similarity these signals have to that expected from a contained nuclear explosion. Under the CTBT Research and Development Program sponsored by the DOE, an experimental task has been developed with the goal of identifying the seismological characteristics of sources associated with mining operations. The complete experimental program consists of four distinct components that include: (1) characterization of mining explosions in hard and soft rock; (2) quantification of decoupling effects; (3) investigation of source depth of burial effects; and (4) characterization of rockbursts and collapses. Items 1 and 4 in this list relate directly to signals generated by mining and compose the topic of this review. Currently, seven experiments are planned under this program with initial results from a number of these reported in other presentations at this meeting. This paper will focus on mining operations in one of the largest coal producing basins in the US, The Powder River Basin. This review is intended to illustrate the magnitude and complexity of mining operations that might produce seismic signals of large enough magnitude to be of interest to CTBT verification.

29986 (LA-UR–95-2702) **The LANL/LLNL/AFTAC Black Thunder Coal Mine regional mine monitoring experiment.** Pearson, D.C.; Stump, B.W.; Baker, D.F.; Edwards, C.L. Los Alamos National Lab., NM (United States). [1995]. 15p. Sponsored by USDOE, Washington, DC (United States). DOE Contract W-7405-ENG-36. (CONF-9509211–1: 17. annual seismic research symposium on monitoring a comprehensive test ban treaty, Scottsdale, AZ (United States), 11-15 Sep 1995). Order Number DE95016946. Source: OSTI; NTIS; GPO Dep.

Cast blasting operations associated with near surface coal recovery provide relatively large explosive sources that generate regional seismograms of interest in monitoring a Comprehensive Test Ban Treaty (CTBT). This paper describes preliminary results of a series of experiments currently being conducted at the Black Thunder Coal Mine in northeast Wyoming as part of the DOE CTBT Research and Development Program. These experiments are intended to provide an integrated set of near-source and regional seismic data for the purposes of quantifying the coupling and source characterization of the explosions. The focus of this paper is on the types of data being recovered with some preliminary implications. The Black Thunder experiments are designed to assess three major questions: (1) how many mining explosions produce seismograms at regional distances that will have to be detected, located and ultimately identified by the National Data Center and what are the waveform characteristics of these particular mining explosions; (2) can discrimination techniques based on empirical studies be placed on a firm physical basis so that they can be applied to other regions where there is little monitoring experience; (3) can large scale chemical explosions (possibly mining explosions) be used to calibrate source and propagation path effects to regional stations, can source depth of burial and decoupling effects be studied in such a controlled environment? With these key questions in mind and given the cooperation of the Black Thunder Mine, a suite of experiments have been and are currently being conducted. This paper will describe the experiments and their relevance to CTBT issues.

29987 (SAND–95-183OC) **A top-down hierarchical approach to the display and analysis of seismic data.** Young, C.J.; Pavlakos, C.; Edwards, T.L. Sandia National Labs., Albuquerque, NM (United States). [1995]. 6p. Sponsored by USDOE, Washington, DC (United States). DOE Contract AC04-94AL85000. (CONF-950954–1: 17. annual electrical overstress/electrostatic discharge symposium, Phoenix, AZ (United States), 11-14 Sep 1995). Order Number DE95016759. Source: OSTI; NTIS; GPO Dep.

Seismic monitoring of a CTBT (Comprehensive Test Ban Treaty) will require analysts to review tens of events per hour recorded by networks of more than a hundred stations. Use of the traditional waveform display as the primary data display tool is incompatible with this requirement; traditional waveform displays are inefficient in their presentation of relevant data and place high demands on computer resources. Drawing on resident data visualization expertise and on our hands-on experience with the design and implementation of the ADSN (AFRAC Distributed Subsurface Network) system at AFTAC, we have designed a new system consisting of a hierarchical series of displays which present Televant information to the analyst in a more efficient manner. The displays are designed to be used in a top-down manner with the analyst starting with the most general display and proceeding to the most specific (the waveform display) only when it is needed. Testing to date has focussed on data from the GSETT2 (Group of Scientific

Experts Technical Test #2) in 1991. Future efforts will be directed towards improved data sets from the ongoing GSETT3.

29988 (UCRL-ID–121824) **The applicability of sample collection and analysis in support of nuclear arms control agreements.** McGuire, R.R. Lawrence Livermore National Lab., CA (United States). 1 Aug 1995. 19p. Sponsored by USDOE, Washington, DC (United States). DOE Contract W-7405-ENG-48. Order Number DE95017465. Source: OSTI; NTIS; GPO Dep.

Agreements are being negotiated to halt the spread of nuclear arms both within the declared nuclear weapons states and to states not heretofore declaring their possession. With the verification regime of the recently negotiated Chemical Weapons Convention (CWC) as a model, negotiators are considering variations of on-site inspection as formulas to enhance the assurance of compliance with future agreements. These on-site inspections may be part of a treaty dictated verification regime or one of a set of voluntary "confidence building" measures. In either case, the collection of material samples for analysis could be an integral component of the inspection as it is in the CWC. The following is an assessment of the applicability of sampling and analysis for compliance monitoring nuclear arms control agreements currently envisioned. There are two essentially orthogonal ways of approaching this question of applicability: the consideration of the analytical questions and the consideration of the specifics of the individual agreements. This study is meant to utilize both approaches in examining the possible impact of sampling and analysis on compliance assessment. First attention must be given to technical questions relating to the efficacy of sampling and analysis.

29989 (UCRL-JC–121749) **LLNL on-site inspection research project: A progress report.** Zucca, J.J.; Carrigan, C.; Schultz, C.; Smith, A.; Sweeney, J.; Pickles, W. Lawrence Livermore National Lab., CA (United States). Jul 1995. 8p. Sponsored by USDOE, Washington, DC (United States). DOE Contract W-7405-ENG-48. (CONF-950954–4: 17. annual electrical overstress/electrostatic discharge symposium, Phoenix, AZ (United States), 11-14 Sep 1995). Order Number DE95016593. Source: OSTI; NTIS; GPO Dep.

We have been developing four specific technology areas that could be used during on-site inspections under a comprehensive test ban treaty: aftershock monitoring, noble gas monitoring, electromagnetic pulse monitoring, and overhead imagery detection of disturbed ground. Our investigation of aftershocks has shown that the low-frequency aftershocks that have been observed after nuclear tests at the Nevada Test Site are also associated with certain kinds of mining operations such as block caving. Our noble gas detection effort has successfully predicted the travel time of two tracer gases emplaced in the Non-Proliferation Experiment. Our EMP effort has developed a stand-off relationship for EMP sensors from the source and to date, has found that mining explosions do not generate significant low-frequency EMP. Our overhead imagery effort suggests that plant stress from shocked ground above an underground explosion may be detected using a ratio of 690 to 420 microns of visible light.

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Refer also to citation(s) 30903

29990 (LA-UR–95-2841) **Resonant ultrasound spectroscopy for materials studies and non-destructive testing.** Migliori, A.; Darling, T.W. Los Alamos National Lab., NM (United States). [1995]. 5p. Sponsored by USDOE, Washington, DC (United States). DOE Contract W-7405-ENG-36. (CONF-9507147–2: 1995 ultrasonics international conference, Edinburgh (United Kingdom), 4-7 Jul 1995). Order Number DE96000013. Source: OSTI; NTIS; GPO Dep.

Short communication. DEFECTS/detection; SOLIDS/nondestructive analysis; SOLIDS/materials testing; RESONANCE; MEASURING INSTRUMENTS; ELASTIC SCATTERING; DEFECTS; DETECTION; SOLIDS

29991 (ORNL/FMP–95/1) **Proceedings of the ninth annual conference on fossil energy materials.** Cole, N.C.; Judkins, R.R. (comps.). Oak Ridge National Lab., TN (United States). Aug 1995. 522p. Sponsored by USDOE, Washington, DC (United States). DOE Contract AC05-84OR21400. (CONF-9505204–: 9. annual conference on fossil energy materials, Oak Ridge, TN (United States), 16-18 May 1995). Order Number DE96001412. Source: OSTI; NTIS; GPO Dep.

The Ninth Annual Conference on Fossil Energy materials was held in Oak Ridge, Tennessee, on May 16–18, 1995. The meeting was sponsored by the US Department of Energy's (DOE) Office of Fossil Energy through the Advanced Research and Technology Development (AR&TD) Materials Program. The objective of the AR&TD Materials Program is to conduct research and development on materials for longer-term fossil energy applications as well as for generic needs of various fossil fuel technologies. The management of the program has been decentralized to the DOE Oak Ridge Operations Office with Oak Ridge National Laboratory (ORNL) as the technical support contractor. The research is performed by staff members at ORNL and by researchers at other national laboratories, universities, and in private industry. The work is divided into the following categories: (1) structural ceramics, (2) new alloys and coatings, (3) functional materials, and (4) technology assessment and transfer. This conference is held each year to review the work on all of the projects of the Program. Selected papers have been processed separately for inclusion in the Energy Science and Technology database.

3601 Metals and Alloys

Refer also to citation(s) 28630, 28976, 28977, 28978, 28999, 29388, 29450, 29502, 29516, 29808, 29891, 29894, 29955, 30091, 30094, 30118, 30132, 30154, 30169, 30190, 30293, 30297, 30318, 30351, 30386, 31120, 31122, 31127, 31130, 31149, 31237

29992 (ANL/ET/CP–84133) **Effects of LWR environments on fatigue life of carbon and low-alloy steels.** Chopra, O.K.; Shack, W.J. Argonne National Lab., IL (United States). Mar 1995. 16p. Sponsored by Nuclear Regulatory Commission, Washington, DC (United States). DOE Contract W-31-109-ENG-38. (CONF-950740–78: Joint ASME/JSME pressure vessels and piping conference, Honolulu, HI (United States), 23-27 Jul 1995). Source: OSTI; NTIS; INIS.

SME Boiler and Pressure Vessel Code provides construction of nuclear power plant components. Figure I-90 Appendix I to Section III of the Code specifies fatigue design curves for structural materials. While effects of environments are not explicitly addressed by the design curves, test data suggest that the Code fatigue curves may not always be adequate in coolant environments. This paper reports the results of recent fatigue tests that examine the effects of steel type, strain rate, dissolved oxygen level, strain range, loading waveform, and surface morphology on the fatigue life of A 106-Gr B carbon steel and A533-Gr B low-alloy steel in water.

29993 (ANL/FPP/TM–287) **U.S. Contribution 1994 Summary Report Task T12: Compatibility and irradiation testing of vanadium alloys.** Smith, D.L. (comp.). Argonne National Lab., IL (United States). Mar 1995. 198p. Sponsored by USDOE, Washington, DC (United States). DOE Contract W-31109-ENG-38. (ITER/US–95/IV-MAT-10). Order Number DE96000984. Source: OSTI; NTIS; INIS; GPO Dep.

Vanadium alloys exhibit important advantages as a candidate structural material for fusion first wall/blanket applications. These advantages include fabricability, favorable safety and environmental features, high temperature and high wall load capability, and long lifetime under irradiation. Vanadium alloys with (3-5)% chromium and (3-5)% titanium appear to offer the best combination of properties for first wall/blanket applications. A V-4Cr-4Ti alloy is recommended as the reference composition for the ITER application. This report provides a summary of the R&D conducted during 1994 in support of the ITER Engineering Design Activity. Progress is reported for Vanadium Alloy Production, Welding, Physical Properties, Baseline Mechanical Properties, Corrosion/Compatibility, Neutron Irradiation Effects, Helium Transmutation Effects on Irradiated Alloys, and the Status of Irradiation Experiments. Separate abstracts have been prepared for individual reports from this publication.

29994 (CONF-910872–10) **Analytical electron microscopy of rapidly solidified metals.** Kelly, T.F.; Holzman, L.M.; Shin, K.; Kim, Y.W.; Bae, J.C.; Flinn, J.E.; Camus, P.P.; Melmed, A.J. Wisconsin Univ., Madison, WI (United States). [1991]. 3p. Sponsored by National Science Foundation, Washington, DC (United States);USDOE, Washington, DC (United States). DOE Contract FG02-85ER45215. Grant DMR 8451933. From Annual Microbeam Analysis Society meeting; San Jose, CA (United States); 4-9 Aug 1991. Order Number DE95016158. Source: OSTI; NTIS; GPO Dep.

Examples of the need to characterize rapidly solidified metals on submicron scale are given for centrifugally atomized steel powder and electrohydrodynamically atomized submicron spheres. Materials studied include Fe-40wt% Ni, 304 SS, Fe-20at.%Co, and pure V.

29995 (CONF-9505204–12) **ODS iron aluminides.** Wright, I.G.; McKamey, C.G.; Pint, B.A. Oak Ridge National Lab., TN (United States). [1995]. 10p. Sponsored by USDOE, Washington, DC (United States). DOE Contract AC05-84OR21400. From 9. annual conference on fossil energy materials; Oak Ridge, TN (United States); 16-18 May 1995. Order Number DE95014253. Source: OSTI; NTIS; GPO Dep.

Since oxide dispersion-strengthened (ODS) FeCrAl-based alloys have sufficient creep strength and good oxidation resistance at the very high temperatures of interest for the primary heat exchanger in advanced, closed-cycle gas turbine systems, they constitute viable alternative candidates to ceramics. A major life-limiting factor of these alloys is the ability to continue to form a protective scale of aluminum oxide, a factor proportional to the total amount of aluminum contained in the alloy. Fe_3Al has oxidation resistance comparable to that of the FeCrAl-based alloys, and significantly superior sulfidation resistance. Also, because of its larger reservoir of aluminum, Fe_3Al would be expected to exhibit longer lifetimes at the temperatures of interest. Since the strengthening effects of ODS processing are expected to confer similar high-temperature creep properties to those found for the FeCrAl-based alloys, ODS-Fe_3Al is considered to have excellent potential for the very high-temperature heat exchanger application. The program effort on ODS Fe_3Al includes examination of the properties of available ODS-FeCrAl alloys; development of mechanical alloying parameters for ODS-Fe_3Al; determination of the effects of a dispersion of reactive element oxides on the high-temperature oxidation behavior of Fe_3Al; and evaluation of methods for joining them.

29996 (CONF-950840–3) **Analysis of the surface structure of HFCVD diamond films.** Mehta, P. (Univ. of Tennessee, Knoxville, TN (United States). Dept. of Chemistry); Feigerle, C.S.; Clausing, R.E.; Heatherly, L.; Thundat, T. Oak Ridge National Lab., TN (United States). [1995]. 6p. Sponsored by USDOE, Washington, DC (United States);National Science Foundation, Washington, DC (United States). DOE Contract AC05-84OR21400. Grant CTS-9202575. From International conference on applications of diamond films and related materials; Gaithersburg, MD (United States); 21-24 Aug 1995. Order Number DE95014263. Source: OSTI; NTIS; GPO Dep.

Structure analysis was carried out on various surface features of diamond films using scanning electron microscopy (SEM) and atomic force microscopy (AFM). The films were grown via hot filament assisted chemical vapor deposition (HFCVD) in methane and hydrogen gas mixtures. The authors investigated the surfaces of films grown under parameters selected to produce certain textures or surface features such as penetration twins or hopper shaped faces. The SEM images of these films show that the {100} planes are usually flatter than the {111}. The {111} planes show interesting growth features. The "hopper" shaped structures were imaged in the tapping mode of the AFM, and the angles between planes and their orientations have been determined. These AFM and SEM images are presented with quantitative analyses of the exposed surfaces. Detailed quantitative information will be useful in understanding the growth of these films.

29997 (CONF-9508134–2) **Modeling phase transformations in ternary systems: Ferrite dissolution during continuous cooling.** Vitek, J.M.; Vitek, S.A. Oak Ridge National Lab., TN (United States). 1995. 14p. Sponsored by USDOE, Washington, DC (United States). DOE Contract AC05-84OR21400. From International symposium on phase transformations during thermal/mechanical processing of steel; Vancouver (Canada); 20-23 Aug 1995. Order Number DE95014255. Source: OSTI; NTIS; GPO Dep.

The diffusion-controlled phase dissolution (or growth) in a ternary system of finite length has been modeled numerically using an implicit finite-difference method. The analysis has been applied to study the ferrite to austenite transformation in austenitic stainless steel weldments. The iron-chromium-nickel ternary system was taken as representative of this class of materials. The effect of system geometry was evaluated by considering planar, cylindrical, and spherical geometries. The numerical analysis was extended to the case of continuous cooling, for a range of cooling rates from 0.1 to 100 K/s. The results provide information on how quickly the system deviates from equilibrium during cooling, and what the final compositions and phase fractions are as a function of cooling rate. In most cases, the deviation from equilibrium, in terms of residual ferrite content and composition, increased as the cooling rate increased, as expected. However, under some conditions, it was found that the lowest cooling rates actually deviated further from equilibrium than intermediate cooling rates. This curious phenomenon was investigated in detail and was explained in terms of the indirect path toward final. Such indirect equilibration is often found during and typical of diffusion-controlled transformation behavior in multi-component systems.

29998 (DOE/CE/15492–T6) **Production of reactive sintered nickel aluminide.** X-Form, Inc., Troy, NY (United States). [1995]. 6p. Sponsored by USDOE, Washington, DC (United States). DOE Contract FG01-91CE15492. Order Number DE96000967. Source: OSTI; NTIS; GPO Dep.

This is the final report pertaining to the development of aluminides by reactive synthesis. Includeci in this report is an overview of results during the scope of this effort, details on specific task accomplishments, and a summary of customer evaluations. Opportunities for future work are also included at the end of this report.

29999 (DOE/ER–0313/17, pp. 3-7) **Status of U.S./Japan collaborative program phase II HFIR target and RB* capsules.** Pawel, J.E. (Oak Ridge National Laboratory, TN (United States)); Lenox, K.E.; Longest, A.W. Oak Ridge National Lab., TN (United States). Apr 1995. In *Fusion materials semiannual progress report for the period ending September 30, 1994.* 390p. Order Number DE95013663. Source: OSTI; NTIS; INIS; GPO Dep.

The objective of the HFIR irradiations is to determine the response of various U.S. and Japanese austenitic and ferritic steels with different pretreatments and alloy compositions to the combined effects of displacement damage and helium generation. Specimen temperatures during irradiation range from 60 to 600°C and fluences range up to 60 dpa. The RB* experiments are a continuation of the ORR spectrally tailored experiments in which the spectrum is modified with a hafnium shield to simulate the expected fusion helium to damage (He/dpa) ratio. In the HFIR target capsules, many specimens have been isotopically tailored in order to achieve fusion helium generation rates.

30000 (DOE/ER–0313/17, pp. 8-14) **Vanadium alloy irradiation experiment X530 in EBR-II*.** Tsai, H. (Argonne National Laboratory, Chicago, IL (United States)); Strain, R.V.; Hins, A.G. Oak Ridge National Lab., TN (United States). Apr 1995. In *Fusion materials semiannual progress report for the period ending September 30, 1994.* 390p. Order Number DE95013663. Source: OSTI; NTIS; INIS; GPO Dep.

The objective of the X530 experiment in EBR-II was to obtain early irradiation performance data, particularly the fracture properties, on the new 500-kg production heat of V-4Cr-4Ti material before the scheduled reactor shutdown at the end of September 1994.

30001 (DOE/ER–0313/17, pp. 17-20) **Vanadium irradiation at ATR - neutronics aspects.** Gomes, I.C. (Argonne National Laboratory, Chicago, IL (United States)); Smith, D.L. Oak Ridge National Lab., TN (United States). Apr 1995. In *Fusion materials semiannual progress report for the period ending September 30, 1994.* 390p. Order Number DE95013663. Source: OSTI; NTIS; INIS; GPO Dep.

Calculations were performed to estimate damage and transmutation rates in vanadium irradiated in the ATR (Advanced Test Reactor) located in Idaho. The main focuses of the study are to evaluate the transmutation of vanadium to chromium and to explore ways to design the irradiation experiment to avoid excessive transmutation. It was found that the A-hole of ATR produces damage rate of ~ 0.2%/dpa of vanadium to chromium. A thermal neutron filter can be incorporated into the design to reduce the vanadium-to-chromium transmutation rate to low levels. A filter 1-2 mm thick of gadolinium or hafnium can be used.

30002 (DOE/ER–0313/17, pp. 28-34) **Neutron dosimetry, damage calculations, and helium measurements for the HFIR-MFE-60J-1 and MFE-330J-1 spectral tailoring experiments.** Greenwood, L.R. (Pacific Northwest Laboratory, Richland, WA (United States)); Baldwin, C.A.; Oliver, B.M. Oak Ridge National Lab., TN (United States). Apr 1995. DOE Contract AC06-76RL01830. In *Fusion materials semiannual progress report for the period ending September 30, 1994.* 390p. Order Number DE95013663. Source: OSTI; NTIS; INIS; GPO Dep.

The objective is to provide dosimetry and damage analysis for fusion materials irradiation experiments. Neutron fluence measurements and radiation damage calculations are reported for the joint US -Japanese MFE-60J-1 and MFE-330J-1 experiments in the hafnium-lined removable beryllium (RB*) position of the High Flux Isotope Reactor (HFIR) at Oak Ridge National Laboratory. These experiments were continuations of the ORR-6J and 7J irradiations performed in the Oak Ridge Research Reactor. The combination of irradiations was designed to tailor the neutron spectrum in order to achieve fusion reactor helium/dpa levels in stainless steel. These experiments produced maximum helium (appm)/dpa(displacement per atom) levels of 10.2 at 18.5 dpa for the ORR-6J and HFIR-MFE-60J-1 combination and 11.8 at 19.0 dpa for the ORR-7J and HFIR-MFE-330J-1 combination. A helium measurement in one JPCA sample was in good agreement with helium calculations.

30003 (DOE/ER–0313/17, pp. 35-50) **Preliminary report on the irradiation conditions of the HFIR JP-23 experiment.** Ermi, A.M. (Westinghouse Hanford Company, Richland, WA (United States)); Gelles, D.S. Oak Ridge National Lab., TN (United States). Apr 1995. DOE Contract AC06-76RL01830. In *Fusion materials semiannual progress report for the period ending September 30, 1994.* 390p. Order Number DE95013663. Source: OSTI; NTIS; INIS; GPO Dep.

The objective of this effort was to irradiate a series of alloys over the temperature range 300 to 600°C to approximately 10 dpa in the High Flux Isotope Reactor (HFIR). The alloys covered a wide range of materials and treatments. The Japanese specimen matrix consisted of ferritic steels, vanadium alloys, copper alloys, molybdenum alloys, and titanium-aluminum compounds. The US specimen matrix consisted of vanadium alloys, 316 stainless steels, and isotopically tailored ferritic and austenitic alloys.

30004 (DOE/ER–0313/17, pp. 55-66) **Correlation between shear punch and tensile data for neutron-irradiated aluminum alloys.** Hamilton, M.L. (Pacific Northwest Laboratory, Richland, WA (United States)); Edwards, D.J.; Toloczko, M.B. Oak Ridge National Lab., TN (United States). Apr 1995. DOE Contract AC06-76RL01830. In *Fusion materials semiannual progress report for the period ending September 30, 1994.* 390p. Order Number DE95013663. Source: OSTI; NTIS; INIS; GPO Dep.

This work was performed to determine whether shear punch and tensile data obtained on neutron irradiated aluminum alloys exhibited the same type of relationship as had been seen in other work and to assess the validity of extrapolating the results to proton-irradiated alloys. This work was also meant to be the first of a series of similar test matrices designed to determine whether the shear punch/tensile relationship varied or was the same for different alloy classes.

30005 (DOE/ER–0313/17, pp. 69-82) **Comparison of defect cluster accumulation and pattern formation in irradiated copper and nickel.** Zinkle, S.J. (Oak Ridge National Lab., TN (United States)); Snead, L.L.; Edwards, D.J. Oak Ridge National Lab., TN (United States). Apr 1995. DOE Contract AC05-84OR21400 ; AC06-76RL01830. In *Fusion materials semiannual progress report for the period ending September 30, 1994.* 390p. Order Number DE95013663. Source: OSTI; NTIS; INIS; GPO Dep.

The objective of this study is to compare the contrasting behavior of defect cluster formation in neutron-irradiated copper and nickel specimens. Transmission electron microscopy was used to examine the density and spatial distribution of defect clusters produced in copper and nickel as the result of fission neutron irradiation to damage levels of 0.01 to 0.25 displacements per atom (dpa) at irradiation temperature between 50 and 230°C. A comparison with published results in the literature indicates that defect cluster wall formation occurs in nickel irradiated at 0.2 to 0.4 T_M in a wide variety of irradiation spectra. Defect cluster wall formation apparently only occurs in copper during low temperature irradiation with electrons and light ions. These results are discussed in terms of the thermal spike model for energetic displacement cascades.

30006 (DOE/ER–0313/17, pp. 85-98) **Effect of internal hydrogen on the mixed-mode I/III fracture toughness of a ferritic/martensitic stainless steel.** Li, H. (Pacific Northwest Lab., Richland, WA (United States)); Jones, R.H.; Gelles, D.S. Oak Ridge National Lab., TN (United States). Apr 1995. DOE Contract AC06-76RL01830. In *Fusion materials semiannual progress report for the period ending September 30, 1994.* 390p. Order Number DE95013663. Source: OSTI; NTIS; INIS; GPO Dep.

The objective is to investigate the effect of hydrogen on mode I and mixed mode I/III fracture toughness at room temperature for a low activation ferritic/martensitic stainless steel (F82-H)

30007 (DOE/ER–0313/17, pp. 99-109) **Dependence of mode I and mixed mode I/III fracture toughness on temperature for a ferritic/martensitic stainless steel.** Li, H. (Pacific Northwest Lab., Richland, WA (United States)); Jones, R.H.; Gelles, D.S. Oak Ridge National Lab., TN (United States). Apr 1995. DOE Contract AC06-76RL01830. In *Fusion materials semiannual progress report for the period ending September 30, 1994.* 390p. Order Number DE95013663. Source: OSTI; NTIS; INIS; GPO Dep.

The objective is to investigate the dependence of mode I and mixed mode I/III fracture toughness on temperature in the range of −95°C to 25°C for a low activation ferritic/martensitic stainless steel (F82-H). Mode I and mixed Mode I/III fracture toughnesses were investigated in the range of −95 to 25°C for a F82-H steel heat-treated in the following way; 1000°C/20 h/air-cooled (AC), 1100°C/7 min/AC, and 700°C/2 h/AC. The results indicate that crack tip plasticity was increased by mixed mode loading, and suggest that at low temperature, mode I fracture toughness is the critical design parameter, but at temperatures above room temperature, expecially concerning fatigure and creep-fatigue crack growth rate, a mixed mode loading may be more harmful than a mode I loading for this steel because a mixed mode loading results in lower fracture toughness and higher crack tip plasticity (or dislocation activity).

30008 (DOE/ER–0313/17, pp. 110-122) **Embrittlement of Cr-Mo steels after low fluence irradiation in HFIR.** Klueh, R.L.; Alexander, D.J. Oak Ridge National Lab., TN (United States). Apr 1995. In *Fusion materials semiannual progress report for the period ending September 30, 1994.* 390p. Order Number DE95013663. Source: OSTI; NTIS; INIS; GPO Dep.

The goal of this work is the determination of the possible effect of the simultaneous formation of helium and displacement damage during irradiation on the Charpy impact behavior. Subsize Charpy impact specimens of 9Cr-1MoVNb (modified 9Cr-1Mo) and 12Cr-1MoVW (Sandvik HT9) steels and 12Cr-1MoVW with 2%Ni (12Cr-1MOVW-2Ni) were irradiated in the High Flux Isotope Reactor (HFIR) at 300 and 400°C to damage levels up to 2.5 dpa. The objective was to study the effect of the simultaneous formation of displacement damage and transmutation helium on impact toghness. Despite the low fluence relative to previous irradiations of these steels, significant increases in the ductile-brittle transition temperature (DBTT) occurred. The 12Cr-1MoVW-2Ni steel irradiated at 400°C had the largest increase in DBTT and displayed indications of intergranular fracture. A mechanism is proposed to explain how helium can affect the fracture behaviour of this latter steel in the present tests, and how it affected all three steels in previous experiments, where the steels were irradiated to higher fluences.

30009 (DOE/ER–0313/17, pp. 125-134) **Initial tensile test results from J316 stainless steel irradiated in the HFIR spectrally tailored experiment.** Pawel, J.E. (Oak Ridge National Lab., TN (United States)); Grossbeck, M.L.; Rowcliffe, A.F. Oak Ridge National Lab., TN (United States). Apr 1995. In *Fusion materials semiannual progress report for the period ending September 30, 1994*. 390p. Order Number DE95013663. Source: OSTI; NTIS; INIS; GPO Dep.

The objective of this work is to determine the effects of neutron irradiation on the mechanical properties of austenitic stainless steel alloys. In this experiment, the spectrum has been tailored to reduce the thermal neutron flux and achieve a He/dpa level near that expected in a fusion reactor.

30010 (DOE/ER–0313/17, pp. 137-141) **Chemical and mechanical interactions of interstitials in V-5%Cr-5%Ti.** DeVan, J.H. (Oak Ridge National Lab., TN (United States)); DiStefano, J.R.; Hendricks, J.W. Oak Ridge National Lab., TN (United States). Apr 1995. In *Fusion materials semiannual progress report for the period ending September 30, 1994*. 390p. Order Number DE95013663. Source: OSTI; NTIS; INIS; GPO Dep.

A vanadium alloy structure with liquid lithium is the favored concept for an advanced breeding blanket for ITER. The objective of this task is to determine the kinetics of reactions of vanadium alloys with hydrogen and oxygen as a function of alloy composition and TMT. Gas-metal reaction studies of V-5Cr-5Ti were conducted to determine the kinetics of reactions with H_2 and O_2, respectively, at 450-500°C. Reaction rates were determined through wieght change measurements and chemical analyses, and effects on mechanical properties were evaluated by room temperature tensile tests.

30011 (DOE/ER–0313/17, pp. 142-151) **Fatigue behavior of unirradiated V-5Cr-5Ti.** Gieseke, B.G. (Oak Ridge National Lab., TN (United States)); Stevens, C.O.; Grossbeck, M.L. Oak Ridge National Lab., TN (United States). Apr 1995. In *Fusion materials semiannual progress report for the period ending September 30, 1994*. 390p. Order Number DE95013663. Source: OSTI; NTIS; INIS; GPO Dep.

The objective of this research is to determine the low cycle fatigue behavior of V-5Cr-5Ti alloys for a range of temperatures and the extent of environmental effects at ambient temperatures. The results of in-vacuum low cycle fatigue tests are presented for unirradiated V-5Cr-5Ti tested at room temperature, 240, and 400°C. A comparison of the fatigue data generated in rough and high vacuums shows that a pronounced environmental degradation of the fatiuge properties exists in this alloy at room temperature. Fatigue life was reduced by as much as 84%. Cyclic stress range data and SEM observations suggest that this reduction is due to a combination of increases in rates of crack initiation and subsequent growth. The relative contribution of each difference is dependent upon the strain range.

30012 (DOE/ER–0313/17, pp. 152-155) **Welding development for V-Cr-Ti alloys.** King, J.F. (Oak Ridge National Lab., TN (United States)); Goodwin, G.M.; Alexander, D.J. Oak Ridge National Lab., TN (United States). Apr 1995. In *Fusion materials semiannual progress report for the period ending September 30, 1994*. 390p. Order Number DE95013663. Source: OSTI; NTIS; INIS; GPO Dep.

A vanadium structure, cooled with helium, is a favored concept for an advanced breeding blanket for fusion systems. The objective of this task is to develop the metallurgical and technological base for the welding of thick sections of V-Cr-Ti. The subsize Charpy test results for electron beam weld metal from the V-5Cr-5Ti alloy has shown significant improvement in Charpy fracture energy compared to both gas tungsten arc weld metal and the base metal itself. These results are preliminary, however, and additional confirmation testing and analysis will be required to explain this improvement in properties.

30013 (DOE/ER–0313/17, pp. 156-164) **Dislocation development in V-5CR-5TI and pure vanadium.** Gelles, D.S. (Pacific Northwest Lab., Richland, WA (United States)); Grossbeck, M.L. Oak Ridge National Lab., TN (United States). Apr 1995. In *Fusion materials semiannual progress report for the period ending September 30, 1994*. 390p. Order Number DE95013663. Source: OSTI; NTIS; INIS; GPO Dep.

The objective of this work is to explain notch sensitivity noted in the candidate alloy V-5Cr-5Ti. Microstructural examinations have been performed on deformed tensile specimens of V-5Cr-5Ti and pure vanadium in order to explain notch sensitivity noted in the candidate alloy V-5Cr-5Ti. SS-3 tensile specimens have been prepared, stress relieved and deformed to 5% strain. The resulting deformation structures have been examined by transmission electron microscopy. It is found that 5% deformation in V-5Cr-5Ti produces a higher dislocation density consisting of long straight dislocations, typical of Stage II, and many small loops, whereas in pure vanadium, the dislocation arrangements are more complex, typical of Stage III, and the small loops are at a lower density.

30014 (DOE/ER–0313/17, pp. 165-177) **Effect of heat treatment on microstructure and fracture toughness of a V-5Cr-5Ti alloy.** Li, H. (Pacific Northwest Lab., Richland, WA (United States)); Hamilton, M.L.; Jones, R.H. Oak Ridge National Lab., TN (United States). Apr 1995. DOE Contract AC06-76RL01830. In *Fusion materials semiannual progress report for the period ending September 30, 1994*. 390p. Order Number DE95013663. Source: OSTI; NTIS; INIS; GPO Dep.

The purpose of this research is to investigate the effect of heat treatment on microstructure and fracture toughness in the range of −50 to 100°C for a V-5Cr-5Ti alloy. Fracture toughness and impact tests were performed on a V-5Cr-5Ti alloy. Specimens annealed at 1125°C for 1 h and furnace cooled in a vacuum of 1.33 x 10^{-5} Pa were brittle at room temperature and experienced a mixture of intergranular and cleavage fracture. The ductile to brittle transition temperature was estimated to be about 20°C. When some specimens were given an additional annealing at 890°C for 24 h, they became very ductile at room temperature and fractured by microvoid coalescence.

30015 (DOE/ER–0313/17, pp. 178-182) **Fabrication of 500-kg heat of V-4Cr-4Ti.** Chung, H.M. (Argonne National Lab., Chicago, IL (United States)); Tsai, H.C.; Smith, D.L. Oak Ridge National Lab., TN (United States). Apr 1995. In *Fusion materials semiannual progress report for the period ending September 30, 1994*. 390p. Order Number DE95013663. Source: OSTI; NTIS; INIS; GPO Dep.

On the basis of excellent properties that were determined for a laboratory-scale heat, V-4Cr-4Ti has been identified previously as the primary vanadium-based candidate alloy for application in fusion reactor structural components. The objective of this work is to produce a large-scale (500-kg) ingot and fabricate various plates and sheets from the ingot, thereby demonstrating a reliable method of fabricating an industrial-scale heat of V-4Cr-4Ti that exhibits excellent properties.

30016 (DOE/ER–0313/17, pp. 183-186) **Impact properties of 500-kg heat of V-4Cr-4Ti.** Chung, H.M. (Argonne National Lab., Chicago, IL (United States)); Nowicki, L.; Gazda, J. Oak Ridge National Lab., TN (United States). Apr 1995. In *Fusion materials semiannual progress report for the period ending September 30, 1994*. 390p. Order Number DE95013663. Source: OSTI; NTIS; INIS; GPO Dep.

Following previous reports of excellent properties of a laboratory heat of V-4Cr-4Ti, the alloy identified as the primary vanadium-based candidate for application as fusion reactor structural components, a large industrial-scale (500-kg) heat of the alloy was fabricated successfully. The objective of this work is to determine the impact properties of the industrial-scale heat.

30017 (DOE/ER–0313/17, pp. 187-193) **Hardness recovery of 85% cold-worked V-Ti and V-Cr-Ti alloys upon annealing at 180°C to 1200°C.** Loomis, B.A. (Argonne National Lab., Chicago, IL (United States)); Nowicki, L.J.; Smith, D.L. Oak Ridge National Lab., TN (United States). Apr 1995. In *Fusion materials semiannual progress report for the period ending September 30, 1994*. 390p. Order Number DE95013663. Source: OSTI; NTIS; INIS; GPO Dep.

The objective of this research is to determine the effect of heat treatment of cold-worked V-Ti and V-Cr-Ti alloys on their resulting microstructures and to correlate the results with the physical and mechanical properties of these alloys. Annealing of 85% cold-worked unalloyed V and V-(1-18)Ti alloys for 1 hr at 180 to 1200°C

results in hardness maxima at 180-250°C, 420-600°C, and 1050-1200°C and in hardness minima at 280-360°C and, depending on Ti concentration in the alloy, at 840-1050°C. Annealing of 85% cold-worked V-(4-15)Cr-(3-6)Ti alloys for 1 hr at 180°C to 1200°C results in harness maxima at 180-250°C, 420-800°C, and 1050-1200°C, and in hardness minima at 280-360°C and 920-1050°C.

30018 (DOE/ER–0313/17, pp. 194-197) **Effect of oxidation on tensile behavior of V-5Cr-5Ti alloy.** Natesan, K. (Argonne National Lab., Chicago, IL (United States)); Soppet, W.K. Oak Ridge National Lab., TN (United States). Apr 1995. In *Fusion materials semiannual progress report for the period ending September 30, 1994*. 390p. Order Number DE95013663. Source: OSTI; NTIS; INIS; GPO Dep.

The objectives of this task are to (a) evaluate the oxygen uptake behavior of V-5Cr-5Ti alloy as a function of temperature and oxygen partial pressure in the exposure environment, (b) examine the microstructural characteristics of oxide scales and oxygen entrapped at the grain boundaries in the substrate alloy, (c) evaluate the influence of oxygen uptake on the tensile properties of the alloy at room and elevated temperatures, (d) evaluate oxidation kinetics of the alloy with the aluminum-enriched surface layers, and (e) determine the effect of oxygen uptake on tensile behavior of the alloy.

30019 (DOE/ER–0313/17, pp. 198-204) **Effect of dynamically charged helium on tensile properties of V-4Cr-4Ti.** Chung, H.M. (Argonne National Lab., IL (United States)); Loomis, B.A.; Nowicki, L.; Smith, D.L. Oak Ridge National Lab., TN (United States). Apr 1995. In *Fusion materials semiannual progress report for the period ending September 30, 1994*. 390p. Order Number DE95013663. Source: OSTI; NTIS; INIS; GPO Dep.

The objective of this work is to determine the effect of displacement damage and dynamically charged helium on tensile properties of V-4Cr-4Ti alloy irradiated to 18-31 dpa at 425-600°C in the Dynamic Helium Charging Experiment (DHCE).

30020 (DOE/ER–0313/17, pp. 205-210) **Ductile-brittle transition behavior of V-4Cr-4Ti irradiated in the dynamic helium charging experiment.** Chung, H.M. (Argonne National Lab., Chicago, IL (United States)); Nowicki, L.J.; Busch, D.E. Oak Ridge National Lab., TN (United States). Apr 1995. In *Fusion materials semiannual progress report for the period ending September 30, 1994*. 390p. Order Number DE95013663. Source: OSTI; NTIS; INIS; GPO Dep.

The objective of this work is to determine the effect of simultaneous displacement damage and dynamically charged helium on the ductile-brittle transition behavior of V-4Cr-4Ti specimens irradiated to 18-31 dpa at 425-600°C in the Dynamic Helium Charging Experiment (DHCE).

30021 (DOE/ER–0313/17, pp. 211-220) **Void structure and density change of vanadium-base alloys irradiated in the dynamic helium charging experiment.** Chung, H.M. (Argonne National Lab., Chicago, IL (United States)); Nowicki, L.; Gazda, J. Oak Ridge National Lab., TN (United States). Apr 1995. In *Fusion materials semiannual progress report for the period ending September 30, 1994*. 390p. Order Number DE95013663. Source: OSTI; NTIS; INIS; GPO Dep.

The objective of this work is to determine void structure, distribution, and density changes of several promising vanadium-base alloys irradiated in the Dynamic Helium Charging Experiment (DHCE). Combined effects of dynamically charged helium and neutron damage on density change, void distribution, and microstructural evolution of V-4Cr-4Ti alloy have been determined after irradiation to 18-31 dpa at 425-600°C in the DHCE, and the results compared with those from a non-DHCE in which helium generation was negligible.

30022 (DOE/ER–0313/17, pp. 221-228) **Effect of fission neutron irradiation on the tensile and electrical properties of copper and copper alloys.** Fabritsiev, S.A. (D.V. Efremov Institute, St. Petersburg (Russian Federation)); Zinkle, S.J.; Rowcliffe, A.F. Oak Ridge National Lab., TN (United States). Apr 1995. In *Fusion materials semiannual progress report for the period ending September 30, 1994*. 390p. Order Number DE95013663. Source: OSTI; NTIS; INIS; GPO Dep.

The objective of this study is to evaluate the properties of several copper alloys following fission reactor irradiation at ITER-relevant temperatures of 80 to 200°C. This study provides some of the data needed for the ITER research and development Task T213. These low temperature irradiations caused significant radiation hardening and a dramatic decrease in the work hardening ability of copper and copper alloys. The uniform elongation was higher at 200°C compared to 100°C, but still remained below 1% for most of the copper alloys.

30023 (DOE/ER–0313/17, pp. 249-252) **Chemical compatibility of structural materials in alkali metals.** Natesan, K. (Argonne National Lab., Chicago, IL (United States)); Rink, D.L.; Haglund, R. Oak Ridge National Lab., TN (United States). Apr 1995. In *Fusion materials semiannual progress report for the period ending September 30, 1994*. 390p. Order Number DE95013663. Source: OSTI; NTIS; INIS; GPO Dep.

The objectives of this task are to (a) evaluate the chemical compatibility of structural alloys such as V-5 wt.%Cr-5 wt.%Ti alloy and Type 316 stainless steel for application in liquid alkali metals such as lithium and sodium-78 wt.% potassium (NaK) at temperatures in the range that are of interest for International Thermonuclear Experimental Reactor (ITER); (b) evaluate the transfer of nonmetallic elements such as oxygen, nitrogen, carbon, and hydrogen between structural materials and liquid metals; and (c) evaluate the effects of such transfers on the mechanical and microstructural characteristics of the materials for long-term service in liquid-metal-environments.

30024 (DOE/ER/52161–T2) **The effects of water radiolysis on the corrosion and stress corrosion behavior of type 316 stainless steel in pure water.** Wyllie, W.E. II; Duquette, D.J.; Steiner, D. Rensselaer Polytechnic Inst., Troy, NY (United States). Nov 1994. 85p. Sponsored by USDOE, Washington, DC (United States). DOE Contract FG02-89ER52161. Order Number DE96001043. Source: OSTI; NTIS; INIS; GPO Dep.

In the ITER Conceptual Design Activity, water will be used as coolant for the major reactor components, which will be made of solution-annealed 316 SS. A concern is that the radiolysis products may increase the stress corrosion cracking (SCC) susceptibility of 316 SS. The corrosion and stress corrosion of 316 SS was observed under irradiated and nonirradiated conditions. Gamma irradiation produced a 100 mV potential shift in the active direction, probably from the polarizing effect of reducing radiolysis products. The irradiation also resulted in nearly an order of magnitude increase in the passive current density of 316 SS, probably from increased surface reaction rates involving radiolysis products as well as increased corrosion rates; however the latter was considered insignificant. Computer simulations of pure water radiolysis at 50, 90, and 130 C and dose rates of 10^{18}-10^{24} were performed; effects of hydrogen, argon, and argon + 20% oxygen deaeration were also studied. Slow strain rate suggest that annealed and sensitized 316 SS was not suscepible to SCC in hydrogen- or argon-deaerated water at 50 C. Modeling of irradiated water chemistry was performed. Open circuit potential of senstizied and annealed 316 SS had a shift of 800 mV in the noble (positive) direction. Steady-state potentials of -0.180 V for sensitized 316 SS wire and -0.096 V vs $Hg/HgSO_4$ for annealed 316 SS wire were independent of oxygen presence. The -0.180 V shift is likely to promote SCC.

30025 (FZR–93) **Dependence of mechanical properties, irradiation and annealing behaviour on the depth position in forgings of the WWER reactor pressure vessel steel 15 Cr2MoV.** Boehmert, J.; Grosse, M.; Viehrig, H.W. Forschungszentrum Rossendorf e.V. (FZR), Rossendorf bei Dresden (Germany). Apr 1995. 181p. (In German). Sponsored by Bundesministerium fuer Bildung, Wissenschaft, Forschung und Technologie, Bonn (Germany). Foerderkennzeichen BMBF 1500918. Order Number DE96706582. Source: OSTI; NTIS (US Sales Only); INIS.

The integrity assessment of the reactor pressure vessel against catastrophic failure refers to the testing of specimens from at least one quarter of the overall wall thickness. This position has been experimentally proven to be the most critical one. For the Russian steels 15Cr2MoV and 15Cr2NiMoV used in the VVER-type pressure vessels the effect has not yet been verified. Therefore hardness, tensile, Charpy-V impact and 3-point bending tests were

carried out to ascertain the dependence of mechanical and fracture mechanics parameters on the depth position and to compare with the results of ASTM-type steels. Besides the differences of the microstructure were investigated by several structure analysis methods. The forgings of VVER-type steels show a relatively insignificant influence of the depth position. The one-quarter-position does not possess the most unfavourable toughness in all cases. This cannot be explained by exclusively considering different cooling rates during quenching. Further effects of the manufacturing process must be taken into account. Irradiation seems to level out the toughness differences. There are no safety-related objections against using of one-quarter-specimens within the framework of the surveillance programmes if in the initial state by testing of specimens over the thickness. (orig.)

30026 (IAEA-TECDOC–794) **Grain size determination in zirconium alloys. Final report of a co-ordinated research programme, 1989-1992.** International Atomic Energy Agency, Vienna (Austria). Apr 1995. 57p. Order Number DE96602538. Source: OSTI; NTIS (US Sales Only); INIS.

A research programme was planned as an exercise to establish procedures and evaluate the success of technology transfer. The first programme under this scheme was proposed by the IAEA on the research topic: grain size determination in zirconium alloys. The host laboratory was Siemens AG Erlangen, in Germany. The programme was supervised by experts selected from participating countries. This report contains the results of the work carried out under this programme. The grain size of Zircaloy, the measurement methods, distribution of grain size in the matrix and dependence of grain size on temperature time of annealing are discussed in this report. The report also includes some information on the organizational arrangements and discusses possibilities for future collaboration. 38 figs, 11 tabs.

30027 (IC–95/162) **Asymptotic description of two metastable processes of solidification for the case of large relaxation time.** Omel'yanov, G.A. International Centre for Theoretical Physics, Trieste (Italy). Jul 1995. 38p. Order Number DE96602539. Source: OSTI; NTIS (US Sales Only); INIS.

The non-isothermal Cahn-Hilliard equations in the n-dimensional case (n = 2,3) are considered. The interaction length is proportional to a small parameter, and the relaxation time is proportional to a constant. The asymptotic solutions describing two metastable processes are constructed and justified. The soliton type solution describes the first stage of separation in alloy, when a set of "superheated liquid" appears inside the "solid" part. The Van der Waals type solution describes the free interface dynamics for large time. The smoothness of temperature is established for large time and the Mullins-Sekerka problem describing the free interface is derived. (author). 46 refs.

30028 (INIS-BR–3547) **Development of electrolytic process in molten salt media for light rare-earth metals production. The metallic cerium electrodeposition.** Restivo, T.A.G. Instituto de Pesquisas Energeticas e Nucleares (IPEN), Sao Paulo, SP (Brazil). 1994. 136p. (In Portuguese). Order Number DE96602535. Source: OSTI; NTIS; INIS.

The development of molten salt process and the respective equipment aiming rare-earth metals recovery was described. In the present case, the liquid cerium metal electrodeposition in a molten electrolytes of cerium chloride and an equimolar mixture of sodium and potassium chlorides in temperatures near 800^{C} was studied. Due the high chemical reactivity of the rare-earth metals in the liquid state and their molten halides, an electrolytic cell was constructed with controlled atmosphere, graphite crucibles and anodes and a tungsten cathode. The electrolytic process variables and characteristics were evaluated upon the current efficiency and metallic product purity. Based on this evaluations, were suggested some alterations on the electrolytic reactor design and upon the process parameters. (author). 90 refs, 37 figs, 20 tabs.

30029 (INIS-mf–14561, pp. 69-73) **First approach for the determination of J-integral R-curves on charpy V-notch specimens.** Krompholz, K. (Paul Scherrer Inst. (PSI), Villigen (Switzerland)); Ullrich, G. [1995]. 125p. In *Paul Scherrer Institut annual report 1994. Annex IV: PSI nuclear energy and safety research progress report 1994.* Order Number DE96601628.

As part of the pressure vessel surveillance programmes of Swiss nuclear power stations, prefatigued, charpy V-notch specimens are currently under irradiation exposure. However, as there is still no consensus as to the correct evaluation procedure for such tests, the conclusions which can be drawn from the results are somewhat limited. This work deals with the alternative possibility of performing the experiments in the same manner as for large, three-point bend-type specimens. The procedure is based upon the proposal of J.R. Rice, which claims that the J-integral is a characteristic value of the material and independent of specimen geometry. If this is the case, then it can be concluded that the specimen size does not play a role in the physical initiation of the propagation of an existing flaw. Exceptions to this rule are only expected in the case of a moving crack. It is shown that the results of the application of this procedure are promising. (author) 4 figs., 14 refs.

30030 (INIS-mf–14586) **Electrodeposition of nickel onto steel, using a thermostatic cell and movable anode by a variable current.** Vega G, J.D. Universidad Autonoma del Estado de Mexico, Toluca (Mexico). Facultad de Quimica. 1994. 98p. (In Spanish). Order Number DE96602536. Source: OSTI; NTIS (US Sales Only); INIS.

In this work, metallic coatings of nickel was made over carbon steel using two different electrolytic solutions: The Watts's bath and the nickel sulfamate bath, using a pulse variable current. The method use was the traditional method, its means a thermostatic cell and one movable anode, which is a few know technique nowadays, it allow realize depositions away from any laboratory or special workshop, it has the advantage to be a portable dispositive. At last of all the electro depositions the coatings quality was valuable by them physical properties like: adhesion, hardness, wrinkled and thickness. The best results was obtain by the Nickel sulfamate bath and movable anode, less in the thickness, which has higher on the thermostatic cell. The variable current was obtain by a Pulse Generator and a Cathodic galvanometer. (Author).

30031 (IS-M–826) **Microstructural evolution, oxidation and wear of Al-Cu-Fe quasicrystalline coatings.** Sordelet, D.J.; Kramer, M.J.; Anderson, I.E.; Besser, M.F. Ames Lab., IA (United States). [1995]. 10p. Sponsored by USDOE, Washington, DC (United States). (CONF-9505288–1: 5. international conference on quasicrystals, Avignon (France), 22-26 May 1995). Order Number DE96000211. Source: OSTI; NTIS; GPO Dep.

Plasma arc sprayed coatings were prepared with two different size fraction starting powders having a nominal composition of $Al_{63}Cu_{25}Fe_{12}$. Powders were obtained by crushing a cast ingot and by gas atomization. Coatings were characterized by electron microscopy, X-ray diffraction and chemical analysis. Oxidation tests were performed in dry oxygen at 500 and 700 C. Finer powders produced coatings with more of the cubic phase than coatings formed with coarser powders. The as-sprayed coatings developed different phases during oxidation. Wear tests of as-sprayed coatings were performed over a range of temperatures in a pin-on-disc arrangement against aluminum oxide. The coefficient of friction increased from around 0.44 at room temperature to near 0.60 at 600 C. Differences in wear behavior of the coatings were seen as a function of temperature.

30032 (IS-M–827) **Microstructure and wear behavior of quasicrystalline thermal sprayed.** Sordelet, D.J.; Krotz, P.D.; Daniel, R.L.; Smith, M.F. Ames Lab., IA (United States). [1994]. 6p. Sponsored by USDOE, Washington, DC (United States). DOE Contract W-7405-ENG-82. (CONF-9409375–1: National thermal spray conference, Houston, TX (United States), Sep 1994). Order Number DE96000213. Source: OSTI; NTIS; GPO Dep.

An Al-Cu-Fe alloy coating which forms a quasicrystalline phase is a potential candidate for replacing electro-deposited chromium on various components in the Space Shuttle Main Engine. Coatings were deposited by air and vacuum plasma spraying and by high-velocity oxygen-fuel spraying. Finer starting powders tended to lose Al during spraying, which affected the phase equilibrium of the coatings. Coatings which retained the starting powder composition were richer in the desired quasicrystalline phase. Ball-on-disk wear tests between 440 C stainless steel ball and the Al-Cu-Fe

coatings were performed. Coefficients of friction ranged from 0.60 to 1.2 for the different coatings.

30033 (IS-T–1735) **Thermal depinning of a single superconducting vortex.** Sok, J. Ames Lab., IA (United States). [1995]. 111p. Sponsored by USDOE, Washington, DC (United States). DOE Contract W-7405-ENG-82. Order Number DE96000886. Source: OSTI; NTIS; GPO Dep.

Thermal depinning has been studied for a single vortex trapped in a superconducting thin film in order to determine the value of the superconducting order parameter and the superfluid density when the vortex depins and starts to move around the film. For the Pb film in $Pb/Al/Al_2O_3/PbBi$ junction having a gold line, the vortex depins from the artificial pinning site (Au line) and reproducibly moves through the same sequence of other pinning sites before it leaves the junction area of the Pb film. Values of the normalized order parameter $\triangle/\triangle_o$ vary from $\triangle/\triangle_o$=0.20 at the first motion of the vortex to $\triangle/\triangle_o$=0.16 where the vortex finally leaves the junction. Equivalently, the value of the normalized superfluid density changes from 4% to 2.5% for this sample in this same temperature interval. For the Nb film in $Nb/Al/Al_2O_3/Nb$ junction, thermal depinning occurs when the value of $\triangle/\triangle_o$ is approximately 0.22 and the value of ρ_s/ρ_{so} is approximately 5%. These values are about 20% larger than those of a Pb sample having a gold line, but the values are really very close. For the Nb sample, grain boundaries are important pinning sites whereas, for the Pb sample with a gold line, pinning may have been dominated by an array Pb_3AU precipitates. Because roughly the same answer was obtained for these rather different kinds of pinning site, there is a reasonable chance that this is a general value within factors of 2 for a wide range of materials.

30034 (JAERI-Research–95-037) **Creep behaviour of hastelloy XR in simulated high-temperature gas-cooled reactor helium.** Kurata, Yuji (Japan Atomic Energy Research Inst., Tokai, Ibaraki (Japan). Tokai Research Establishment); Suzuki, Tomio; Shindo, Masami; Ogawa, Yutaka; Nakajima, Hajime; Kondo, Tatsuo. Japan Atomic Energy Research Inst., Tokyo (Japan). Jun 1995. 49p. Order Number DE96701326. Source: OSTI; NTIS; INIS.

Creep tests of Hastelloy XR (a modified version of the conventional Hastelloy X) were carried out in simulated high-temperature gas-cooled reactor helium at 800, 900 and 1000degC. The test results up to about 50,000h showed no significant degradation in creep properties such as the rupture life, rupture ductility and the steady-state creep rate. The creep-rupture strength obtained through long-term tests was above the level corresponding to the design allowable creep-rupture stress of the High-Temperature Engineering Test Reactor. The values of the stress exponent were 4.5 to 5.7 when the stress dependence of the steady-state creep rate was expressed in terms of the Norton equation. Rupture lives could be estimated with sufficient accuracy using Larson-Miller parameter. Carbon analysis for ruptured specimens showed that carburization was limited to the region near the ruptured portion. The surface crack tips were blunted at the depth of 100 to 200μm from the specimen surface. Internally formed cracks were initiated at sites of precipitates at grain boundaries, growing nearly perpendicular to the stress axis. The electron probe microanalysis revealed that two precipitates, Mo-rich phase and Cr-rich phase, co-existed. (author).

30035 (LA-SUB–93-155) **Research on hydrogen effects on phase distribution ahead of propagating cracks in stainless steel. Final report.** Altstetter, C. (Univ. of Illinois, Urbana, IL (United States). Dept. of Materials Science and Engineering). Los Alamos National Lab., NM (United States); Illinois Univ., Urbana, IL (United States). Dept. of Materials Science and Engineering. [1993]. 7p. Sponsored by USDOE, Washington, DC (United States). DOE Contract W-7405-ENG-36. Subcontract 9-HG0-H0655-1. Order Number DE96000175. Source: OSTI; NTIS; GPO Dep.

This research was performed in support of computations to determine the distribution of hydrogen at a crack tip in an unstable stainless steel. It involved metallographic observations of the distribution of martensite at a stressed crack tip. It is concluded that the martensite phase distribution is much too fine to model realistically by the finite element method when far-field stress effects must be included. The mesh size would have to be less than 50 micrometers in order to include the effects of non-uniform distribution of martensite within a single grain. This would lead to unrealistic computation times. A reasonable compromise is to assume that a finite element will be considered to change from the hydrogen diffusivity of the austenite to that of the bcc martensitic phase when the yield stress of the austenite has been reached. This should give a significantly different hydrogen distribution from the case of untransforming austenite and allow the FEM computations to verify or disprove the kinetic model of hydrogen embrittlement of unstable austenitic stainless steels.

30036 (LA-UR–95-2590) **Constitutive modeling using the Taylor impact test.** Jones, S.E. (Univ. of Alabama, Tuscaloosa, AL (United States). Dept. of Mechanical Engineering); Maudlin, P.J.; Foster, J.C. Jr. Los Alamos National Lab., NM (United States). [1995]. 8p. Sponsored by USDOE, Washington, DC (United States). DOE Contract W-7405-ENG-36. (CONF-9511120–1: Symposium on high strain rate effects on polymers metal and ceramic matrix composites and other advanced materials, San Francisco, CA (United States), 14 Nov 1995). Order Number DE95016979. Source: OSTI; NTIS; GPO Dep.

The Taylor test can be conveniently divided into three fairly distinct stages: (1) initial transient behavior after impact characterized by nonlinear plastic wave propagation. (2) quasi-steady propagation of the plastic wave front. The duration of this stage is a function of specimen caliber and material. (3) terminal transient behavior, during which most of the deceleration of the undeformed section takes place. After the initial transient is complete, which varies with the strain at which the plastic wave front propagates, the motion is well behaved, in the sense that a one-dimensional analysis can be effectively applied. This paper contains such an analysis. Results are supported by an example from which the state of stress for an OFHC copper specimen is deduced.

30037 (LA-UR–95-2746) **Constitutive modeling for hypervelocity cratering.** Davidson, R.F.; Walsh, M.L. Los Alamos National Lab., NM (United States). [1995]. 5p. Sponsored by Department of Defense, Washington, DC (United States). DOE Contract W-7405-ENG-36. (CONF-950846–60: American Physical Society biennial conference on shock compression of condensed matter, Seattle, WA (United States), 13-18 Aug 1995). Order Number DE96000017. Source: OSTI; NTIS; GPO Dep.

The Hypervelocity Microparticle Impact program conducted cratering experiments on copper and aluminum targets at impact velocities up to 30 km/s. These data are presented with minor corrections in a form that will be useful to a variety of investigators. Hydrocode analysis of the data was performed to gain understanding of the plateau features in the data. Analyses using conventional strength models were not satisfactory due to the very high strain rates of these experiments (strain rates on the order of 10^{10}/s). Calculations using the PTW strength model rate dependence gave very accurate reproduction of the experimental results, and allowed computational examination of the data plateaus. These results show that the data plateaus may be due to strain-rate effects and experimental variation in the data.

30038 (LA-UR–95-2826) **Deformation response of Zr after shock-loading.** Song, S.G.; Gray, G.T. III; Lopez, M.F. Los Alamos National Lab., NM (United States). [1995]. 6p. Sponsored by Department of Defense, Washington, DC (United States). DOE Contract W-7405-ENG-36. (CONF-950846–48: American Physical Society biennial conference on shock compression of condensed matter, Seattle, WA (United States), 13-18 Aug 1995). Order Number DE96000008. Source: OSTI; NTIS; GPO Dep.

The post-shock stress-strain response and microstructural evolution of Zr shock-loaded to 7 GPa were investigated. A Bauschinger effect in the room temperature reload stress-strain behavior due to shock-loading has been observed following yielding. Deformation twinning is shown to play a more important role than slip during post-shock plastic deformation and work hardening. The work hardening rate of the shock-prestrained specimens is less temperature sensitive than that of annealed Zr. The underlying microstructures responsible for the Bauschinger effect and the differences in work hardening behavior are characterized. A new type of dense dislocation arrangement resulting from phase transformations during shock excursion is discussed.

30039 (LA-UR–95-2833) **Magnetic anisotropy of U_2Pd_2In.** Prokes, K. (Univ. of Amsterdam (Netherlands). Van der Walls-Zeeman Inst.); Nakotte, H.; Havela, L. Los Alamos National Lab., NM (United States). [1995]. 9p. Sponsored by USDOE, Washington, DC (United States). DOE Contract W-7405-ENG-36. (CONF-9509209–3: International conference on strongly correlated electron systems, Goa (India), 27-30 Sep 1995). Order Number DE96000009. Source: OSTI; NTIS; INIS; GPO Dep.

Magnetic susceptibility studies of the U_2Pd_2In single crystal show that in the paramagnetic state larger χ-values are found for field along the basal plane than along the c-axis. However, below T_N = 37 K, where U-moments form a non-collinear magnetic structure within the basal plane, a cross-over of the two χ-branches occurs. The single crystal results may explain the origin of the exotic magnetization results obtained on powder samples.

30040 (LA-UR–95-2884) **The effect of structural defects in SiC particles on the static & dynamic mechanical response of a 15 volume percent SiC/6061-Al matrix composite.** Vaidya, R.U.; Song, S.G.; Zurek, A.K.; Gray, G.T. III. Los Alamos National Lab., NM (United States). [1995]. 6p. Sponsored by USDOE, Washington, DC (United States). DOE Contract W-7405-ENG-36. (CONF-950846–62: American Physical Society biennial conference on shock compression of condensed matter, Seattle, WA (United States), 13-18 Aug 1995). Order Number DE96000004. Source: OSTI; NTIS; GPO Dep.

Static and Dynamic mechanical tests, and microstructural examinations performed on a SiC particle reinforced 6061-Al matrix composite indicated that particle cracking significantly affected the strength, strain hardening, and failure mechanism of the composite. Cracks were observed to nucleate and propagate on stacking faults and interfaces between the various phases within the reinforcing SiC particles. Planar defects were the predominant artifacts seen in the SiC particles. Partial dislocations were also observed bounding the stacking faults within the reinforcement phase.

30041 (LA-UR–95-2913) **Electronic properties of U_2Pt_2Sn.** Prokes, K. (Amsterdam Univ. (The Netherlands). Van der Waals-Zeeman Inst.); de Boer, F.R.; Nakotte, H. Los Alamos National Lab., NM (United States). [1995]. 7p. Sponsored by USDOE, Washington, DC (United States). DOE Contract W-7405-ENG-36. (CONF-951101–3: 40. conference on magnetism and magnetic materials, Philadelphia, PA (United States), 6-9 Nov 1995). Order Number DE96000041. Source: OSTI; NTIS; INIS; GPO Dep.

U_2Pt_2Sn is crystallizing in an ordered version (space group $P4_2/mnm$) of the tetragonal U_3Si_2-type of structure. Clear anomalies in the magnetic susceptibility, specific heat and electrical resistivity around 15 K indicate that U_2Pt_2-Sn orders antiferromagnetically below this temperature. As expected for an antiferromagnet, the susceptibility and specific heat anomalies are shifted to lower temperatures upon application of external magnetic field. The specific-heat coefficient γ = 327 mJ/mol f.u. K^2 remains unchanged in fields up to 5T. The antiferromagnetic ground state of U_2Pt_2Sn can be concluded also from the metamagnetic transition around 22 T in the magnetization at 4.2 K and from magnetic reflections in the neutron-diffraction pattern at low temperatures.

30042 (LA-UR–95-2920) **Ductile damage modeling based on void coalescence and percolation theories.** Tonks, D.L.; Zurek, A.K.; Thissell, W.R. Los Alamos National Lab., NM (United States). [1995]. 10p. Sponsored by USDOE, Washington, DC (United States). DOE Contract W-7405-ENG-36. (CONF-950856–4: 4. international conference on metallurgical and materials applications of shock-wave and high-strain-rate phenomena, El Paso, TX (United States), 6-10 Aug 1995). Order Number DE96000033. Source: OSTI; NTIS; GPO Dep.

A general model for ductile damage in metals is presented. It includes damage induced by shear stress as well as damage caused by volumetric tension. Spallation is included as a special case. Strain induced damage is also treated. Void nucleation and growth are included, and give rise to strain rate effects. Strain rate effects also arise in the model through elastic release wave propagation between damage centers. The underlying physics of the model is the nucleation, growth, and coalescence of voids in a plastically flowing solid. The model is intended for hydrocode based computer simulation. An experimental program is underway to validate the model.

30043 (LA-UR–95-2954) **Electronic properties of UCuSn.** Nakotte, H. (Los Alamos National Lab., NM (United States)); Purwanto, A.; Robinson, R.A.; Prokes, K.; Boer, F.R. de; Havela, L.; Sechovsky, V.; Swainson, I. Los Alamos National Lab., NM (United States). [1995]. 10p. Sponsored by USDOE, Washington, DC (United States). DOE Contract W-7405-ENG-36. (CONF-951101–2: 40. conference on magnetism and magnetic materials, Philadelphia, PA (United States), 6-9 Nov 1995). Order Number DE96000026. Source: OSTI; NTIS; INIS; GPO Dep.

Crystallographic analysis shows that UCuSn does not form in the hexagonal $CaIn_2$ structure as reported previously, but is an ordered ternary compound and forms in an orthorhombic structure. Bulk and neutron-diffraction measurements reveal that UCuSn orders antiferromagnetically below 60 K. At 4.2 K, high-field magnetization reveal a complex magnetization process with two metamagnetic transitions. Furthermore, bulk investigations show an additional anomaly at 25 K, but a regular temperature dependence of various magnetic peaks down to the lowest temperature gives no evidence for a second magnetic transition. Possible scenarios responsible for the drastic changes in the electronic properties around 25 K are discussed.

30044 (LA-UR–95-2992) **Spall behavior and damage evolution in tantalum.** Zurek, A.K.; Thissell, W.R.; Tonks, D.L. Los Alamos National Lab., NM (United States). [1995]. 5p. Sponsored by Department of Defense, Washington, DC (United States). DOE Contract W-7405-ENG-36. (CONF-9509226–4: 15. Association for the International Advancement of High Pressure & Technology international conference, Warsaw (Poland), 11-15 Sep 1995). Order Number DE96000018. Source: OSTI; NTIS; INIS; GPO Dep.

The authors conducted a number of plate impact experiments using an 80-mm launcher to study dynamic void initiation, linkup, and spall in tantalum. The tests ranged in shock pressure so that the transition from void initiation, incipient spall, and full spall could be studied. Wave profiles were measured using a velocity interferometry system (VISAR), and targets were recovered using soft recovery techniques. The authors utilized scanning electron microscopy, metallographic cross-sections, and plateau etching to obtain quantitative information concerning damage evolution in tantalum under spall conditions. The data (wave profiles and micrographs) are analyzed in terms of a new theory and model of dynamic damage cluster growth. They have developed a model of ductile damage based on void coalescence of initially nucleated voids, that leads to clusters of voids. At low loading strain rates, the biggest cluster has time to grow much more rapidly than smaller clusters to break the sample. At high loading strain rates, large clusters cannot grow any faster than smaller clusters so the sample breaks when enough clusters grow independently to form a fracture surface by random accumulation.

30045 (LA-UR–95-3036) **Studies of sliding friction in compressed copper.** Hammerberg, J.E.; Holian, B.L.; Zhou, S.J. Los Alamos National Lab., NM (United States). [1995]. 5p. Sponsored by USDOE, Washington, DC (United States). DOE Contract W-7405-ENG-36. (CONF-950846–58: American Physical Society biennial conference on shock compression of condensed matter, Seattle, WA (United States), 13-18 Aug 1995). Order Number DE96000065. Source: OSTI; NTIS; GPO Dep.

We present the results of simulations for sliding copper interfaces for pressures in the kilobar range. The velocity dependence and density dependence are discussed and the evolution of plastic damage is described. Density dependence embedded atom model (EAM) potentials are used to describe the atomic interactions. Simulations were typically for N=65,000 atoms and were carried out using molecular dynamics on massively parallel CM200 and CM5 platforms. A transition to a low friction state at high velocities is discussed.

30046 (LA-UR–95-3046) **The structure, properties and performance of plasma-sprayed beryllium for fusion applications.** Castro, R.G. (and others); Stanek, P.W.; Elliott, K.E. Los Alamos National Lab., NM (United States). [1995]. 15p. Sponsored by

USDOE, Washington, DC (United States). DOE Contract W-7405-ENG-36. (CONF-9509218–1: 2. International Energy Agency workshop on beryllium technology for fusion, Jackson, WY (United States), 6-8 Sep 1995). Order Number DE96000066. Source: OSTI; NTIS; INIS; GPO Dep.

Plasma-spray technology is under investigation as a method for producing high thermal conductivity beryllium coatings for use in magnetic fusion applications. Recent investigations have focused on optimizing the plasma-spray process for depositing beryllium coatings on damaged beryllium surfaces. Of particular interest has been optimizing the processing parameters to maximize the through-thickness thermal conductivity of the beryllium coatings. Experimental results will be reported on the use of secondary H_2 gas additions to improve the melting of the beryllium powder and transferred-arc cleaning to improve the bonding between the beryllium coatings and the underlying surface. Information will also be presented on thermal fatigue tests which were done on beryllium coated ISX-B beryllium limiter tiles using 10 sec cycle times with 60 sec cooldowns and an International Thermonuclear Experimental Reactor (ITER) relevant divertor heat flux slightly in excess of 5 MW/m^2.

30047 (LA-UR–95-3057) **Elevated temperature stress strain behavior of beryllium powder product.** Abeln, S.P. (Los Alamos National Lab., NM (United States)); Field, R.; Mataya, M.C. Los Alamos National Lab., NM (United States). [1995]. 33p. Sponsored by USDOE, Washington, DC (United States). DOE Contract W-7405-ENG-36. (CONF-9509218–2: 2. International Energy Agency workshop on beryllium technology for fusion, Jackson, WY (United States), 6-8 Sep 1995). Order Number DE96000072. Source: OSTI; NTIS; INIS; GPO Dep.

Several grades of beryllium powder product were tested under isothermal conditions in compression over a temperature range of room temperature to 1000 C and a strain rate range from 0.001 s^{-1} to 1 s^{-1}. Samples were compressed to a total strain of 1 (64% reduction in height). It is shown that all the grades are strain rate sensitive and that strain rate sensitivity increases with temperature. Yield points were exhibited by some grades up to a temperature of 500 C, and appeared to be primarily dependent on prior thermal history which determined the availability of mobile dislocations. Serrated flow in the form of stress drops was seen in all the materials tested and was most pronounced at 500 C. The appearance and magnitude of the stress drops were dependent on accumulated strain, strain rate, sample orientation, and composition. The flow stress and shape of the flow curves differed significantly from grade to grade due to variations in alloy content, the size and distribution of BeO particles, aging precipitates, and grain size. The ductile-brittle transition temperature (DBTT) was determined for each grade of material and shown to be dependent on composition and thermal treatment. Structure/property relationships are discussed using processing history, microscopy (light and transmission), and property data.

30048 (LA-UR–95-3125) **Oxide scale stresses in polycrystalline Cu/Cu_2O system.** Jayaraman, N.; Rangaswamy, P. Los Alamos National Lab., NM (United States). [1995]. 10p. Sponsored by USDOE, Washington, DC (United States). DOE Contract W-7405-ENG-48. (CONF-9507170–2: Advances in X-ray analysis, Denver, CO (United States), Jul 1995). Order Number DE96000070. Source: OSTI; NTIS; GPO Dep.

An x-ray diffraction ($\sin^2\Psi$) method has been successfully used to measure the oxidation stresses at room temperature in annealed and electropolished samples of polycrystalline Cu coupons of different thickness (0.75, 1.25, and 2.25 mm thick) oxidized for 15 and 30 minutes at temperatures 700, 800, and 900 C. Oxide scale stresses are generally a result of both differential Coefficient of Thermal Expansion (CTE) and the Piling-Bedworth Ratio (PBR). At the oxidation temperatures of this study, the oxide scale consisted of a mixture of both CuO and Cu_2O. Residual stress measurements were made in the Cu_2O phase. In this system, the stresses on the free surface of the oxide (σ_{11} and σ_{22}) were compressive and the average stress through the thickness ($<\sigma>_{33}$) normal to the oxide layer was found to be tensile. Surface stresses (σ_{11} and σ_{22}) on the oxides formed at temperatures were found to be independent of orientation and both surface stresses and the average normal stresses ($<\sigma>_{33}$) generally decreased with increasing temperature of oxidation. Increasing the time of oxidation generally resulted in a decreased stress values. Effects of increasing the substrate thickness at a given temperature and time were to increase the oxide scale stresses. These results are interpreted in terms of oxide growth rate, and deformation/plasticity of the substrate and the oxide scale and fracture/flow of the oxide scale.

30049 (LA-UR–95-3126) **Residual stress and microstructural characterization using Rietveld refinement of a carburized layer in a 5120 steel.** Rangaswamy, P.; Bourke, M.A.M.; Lawson, A.C.; O'Rourke, J.; Goldstone, J.A. Los Alamos National Lab., NM (United States). [1995]. 13p. Sponsored by USDOE, Washington, DC (United States). DOE Contract W-7405-ENG-36. (CONF-9507170–1: Advances in X-ray analysis, Denver, CO (United States), Jul 1995). Order Number DE96000038. Source: OSTI; NTIS; GPO Dep.

Rietveld refinement of X-ray diffraction patterns has been used to provide microstructural information complementary to conventional X-ray residual stress measurements through a carburized layer containing a maximum vol. 25 % of retained austenite. Layers in a simple specimen were removed incrementally by electropolishing and, at each depth in addition to conventional residual stress measurements in both the martensite and retained austenite, data were collected at $\Psi = 0$ for Rietveld refinement. The refinements provide accurate values for the lattice parameters in the respective phases that can be related to carbon content and microstructure. Besides to providing qualitative information concerning the microstructure and possible surface decarburization, the c/a ratio of the martensite potentially offers an independent technique for determining carbon content profiles.

30050 (LA-UR–95-3127) **Experimental measurement and numerical simulation of residual stresses in a carburized layer of a 5120 steel.** Rangaswamy, P.; Bourke, M.A.M.; Shipley, J.C.; Goldstone, J.A. Los Alamos National Lab., NM (United States). [1995]. 8p. Sponsored by USDOE, Washington, DC (United States). DOE Contract W-7405-ENG-36. (CONF-951222–1: International conference on carburizing and nitriding with atmospheres, Cleveland, OH (United States), 6-8 Dec 1995). Order Number DE96000034. Source: OSTI; NTIS; GPO Dep.

A combined experimental and numerical study of residual stress and microstructure has been performed for a carburized steel 5120 specimen. Specimens were cut from 5120 steel bar stock, in the shape of hockey pucks and were subsequently carburized and quenched. X-ray diffraction was used to record stress profiles through the case for the martensite and retained austenite on the two flat surfaces oriented up and down during the quench. Layer removal was performed by electropolishing. Rietveld analysis was used to determine the lattice parameters of the phases at each depth varying with both carbon content and stress. The experimental measurements are compared with a numerical simulation of the phase transformation and the metallurgical changes following the carburization and quench. Results am discussed in the context of the microstructure and the role played by the retained austenite in interpretation. In addition the carbon profile obtained from the lattice parameters is compared with profiles measured using burnout.

30051 (LA-UR–95-3145) **An application of multisurface plasticity theory: Yield surfaces of textured materials.** Maudlin, P.J. (and others); Wright, S.I.; Kocks, U.F. Los Alamos National Lab., NM (United States). [1995]. 6p. Sponsored by USDOE, Washington, DC (United States). DOE Contract W-7405-ENG-36. (CONF-9509226–2: 15. Association for the International Advancement of High Pressure & Technology international conference, Warsaw (Poland), 11-15 Sep 1995). Order Number DE96000064. Source: OSTI; NTIS; GPO Dep.

Directionally dependent descriptions of the yield behavior of metals as determined by polycrystal plasticity computations are discrete in nature and, in principle, are available for use in large-scale application calculations employing multi-dimensional continuum mechanics codes. However, the practical side of using such detailed yield surfaces in application calculations contains some challenges in terms of algorithm development and computational efficiency. Discrete representations of yield as determined from

Taylor-Bishop-Hill polycrystal calculations can be fitted or tessellated into a multi-dimensional piece-wise linear yield surface for subsequent use in constitutive algorithms for codes. Such an algorithm that utilizes an associated flow based multisurface plasticity theory has been implemented in the three dimensional EPIC code and is described in this effort.

30052 (LA-UR–95-17922, pp. 890-901) **An overview of the PIREX Proton Irradiation facility and its research program.** Victoria, M. (Association EURATOM. Villigen (Switzerland)); Gavillet, D. Los Alamos National Lab., NM (United States). [1995]. (CONF-9407103–: International conference on accelerator-driven transmutation technologies and applications, Las Vegas, NV (United States), 25 Jul - 1 aug 1994). In *AIP conference on accelerator driven transmutation technologies and applications, Los Vegas, Nevada, July 25-29, 1994.* 958p. Order Number DE95014018. Source: OSTI; NTIS; INIS.

The main design characteristics of PIREX (Proton Irradiation Experiment) are described. The facility is installed in the 590 MeV proton beam of the PSI accelerator system. Its main task is the irradiation and testing of fusion reactor candidate materials. Protons of this energy produce simultaneously in the target material displacement damage and impurities, amongst them helium. They can therefore simulate possible synergistic effects between helium and damage that would result from irradiations with the fusion neutrons. The research program being developed includes studies on both materials of technological interest, such as martensitic stainless steels and Mo - based alloys and basic radiation damage research on pure metals. The facility is also being used for actinide transmutation studies, in the so called ATHENA experiment. The main directions of the research program are described and examples of present results are given.

30053 (LA-UR–95-17922, pp. 903) **Materials performance experience at spallation neutron sources.** Sommer, W.F. (Los Alamos National Laboratory, NM (United States)). Los Alamos National Lab., NM (United States). [1995]. (CONF-9407103–: International conference on accelerator-driven transmutation technologies and applications, Las Vegas, NV (United States), 25 Jul - 1 aug 1994). In *AIP conference on accelerator driven transmutation technologies and applications, Los Vegas, Nevada, July 25-29, 1994.* 958p. Order Number DE95014018. Source: OSTI; NTIS; INIS.

There is a growing, but not yet substantial, data base for materials performance at spallation neutron sources. Specially designed experiments using medium energy protons (650 MeV) have been conducted at the Proton Irradiation Experiment (PIREX) facility at the Swiss Nuclear Institute accelerator (SIN). Specially designed experiments using 760-800 MeV copper target have been completed at the Los Alamos Spallation Radiation Effects Facility (LASREF) at Los Alamos Meson Physics Facility (LAMPF). An extensive material testing program was initiated at LASREF in support of the German spallation neutron source (SNQ) project, before it terminated in 1985.

30054 (LA-UR–95-17922, pp. 939-940) **Summary of the materials breakout group.** Garner, F. (Pacific Northwest Laboratories, Richland, WA (United States)): Sommer, W. Los Alamos National Lab., NM (United States). [1995]. (CONF-9407103–: International conference on accelerator-driven transmutation technologies and applications, Las Vegas, NV (United States), 25 Jul - 1 aug 1994). In *AIP conference on accelerator driven transmutation technologies and applications, Los Vegas, Nevada, July 25-29, 1994.* 958p. Order Number DE95014018. Source: OSTI; NTIS; INIS.

This breakout group discussed the following topics and reached a number of recommendations summarized in this report. The topics of discussion included (1) a comparison of expected materials response at spallation sources to experience with fission reactors; (2) synergistic effects from high-energy particle radiation, corrosion, and cyclic stresses; (3) estimates, based on experience with materials developed for fission and fusion reactors, for -materials testing needs; - facilities for materials development, both available and needed; - candidate materials; - time frame for material qualification; and - expected program costs.

30055 (LBL–36783) **In-situ deposition of sacrificial layers during ion implantation.** Anders, A.; Anders, S.; Brown, I.G.; Yu, K.M. Lawrence Berkeley Lab., CA (United States). Feb 1995. 14p. Sponsored by USDOE, Washington, DC (United States);Electric Power Research Inst., Palo Alto, CA (United States). DOE Contract AC03-76SF00098. (CONF-950220–10: 9. international conference on ion beam modification of materials, Canberra (Australia), 5-10 Feb 1995). Order Number DE96000124. Source: OSTI; NTIS; INIS; GPO Dep.

The retained dose of implanted ions is limited by sputtering. It is known that a sacrificial layer deposited prior to ion implantation can lead to an enhanced retained dose. However, a higher ion energy is required to obtain a similar implantation depth due to the stopping of ions in the sacrificial layer. It is desirable to have a sacrificial layer of only a few monolayers thickness which can be renewed after it has been sputtered away. We explain the concept and describe two examples: (i) metal ion implantation using simultaneously a vacuum arc ion source and filtered vacuum arc plasma sources, and (ii) Metal Plasma Immersion Ion Implantation and Deposition (MePIIID). In MePIIID, the target is immersed in a metal or carbon plasma and a negative, repetitively pulsed bias voltage is applied. Ions are implanted when the bias is applied while the sacrificial layer suffers sputtering. Low-energy thin film deposition - repair of the sacrificial layer – occurs between bias pulses. No foreign atoms are incorporated into the target since the sacrificial film is made of the same ion species as used in the implantation phase.

30056 (LBL–37640) **Angle-resolved photoemission extended fine structure: Multiple layers of emitters and multiple initial states.** Huff, W.R.A. (Lawrence Berkeley Lab., CA (United States)); Kellar, S.A.; Moler, E.J.; Chen, Y.; Wu, H.; Shirley, D.A.; Hussain, Z. Lawrence Berkeley Lab., CA (United States). Aug 1995. 4p. Sponsored by USDOE, Washington, DC (United States). DOE Contract AC03-76SF00098. (LSBL–276; CONF-950859–2: 11. international conference on vacuum ultraviolet radiation physics, Tokyo (Japan), 27 Aug - 1 sep 1995). Order Number DE96001119. Source: OSTI; NTIS; GPO Dep.

Recently, angle-resolved photoemission extended fine structure (ARPEFS) has been applied to experimental systems involving multiple layers of emitters and non-s core-level photoemission in an effort to broaden the utility of the technique. Most of the previous systems have been comprised of atomic or molecular overlayers adsorbed onto a single-crystal, metal surface and the photoemission data were taken from an s atomic core-level in the overlayer. For such a system, the acquired ARPEFS data is dominated by the p_0 final state wave backscattering from the substrate atoms and is well understood. In this study, we investigate ARPEFS as a surface-region structure determination technique when applied to experimental systems comprised of multiple layers of photoemitters and arbitrary initial state core-level photoemission. Understanding the data acquired from multiple layers of photoemitters is useful for studying multilayer interfaces, "buried" surfaces, and clean crystals in ultra-high vacuum. The ability to apply ARPEFS to arbitrary initial state core-level photoemission obviously opens up many systems to analysis. Efforts have been ongoing to understand such data in depth. We present clean Cu(111) 3s, 3p, and 3d core-level, normal photoemission data taken on a high resolution soft x-ray beamline 9.3.2 at the Advanced Light Source in Berkeley, California and clean Ni(111) 3p normal photoemission data taken at the National Synchrotron Light Source in Upton, New York, USA.

30057 (MLM–193) **Electrodeposition progress report, September 1–30, 1948.** Orban, E. Mound Lab., Miamisburg, OH (United States). [1948]. 28p. Sponsored by USDOE, Washington, DC (United States). DOE Contract AC04-76DP00053. Order Number DE96001481. Source: OSTI; NTIS; GPO Dep.

Two difficulties which have been encountered in the attempts to prepare hydrofluoric acid solutions by precipitation and resolution are (1) dissolution of postum out of the solid precipitate leaving behind a solid bismuth compound and (2) the plastics used for a reaction vessel. Plastics tried have not held up under the combined effects of hydrofluoric acid, moderate heat, and alpha bombardment and the overall yield of the method is rather low. The plastics

problem may be solved by the use of "Fluorothene" which is on order from the Atomic Energy Commission and should arrive soon. The problem of leaching the postum from the precipitate may be solved by careful control of pH during precipitation procedure to avoid the precipitation of as much bismuth as possible.

30058 (MLM–213) **Electrodeposition progress report, October 1–31, 1948.** Orban, E. Mound Lab., Miamisburg, OH (United States). [1948]. 20p. Sponsored by USDOE, Washington, DC (United States). DOE Contract AC24-88DP43495. Order Number DE96001505. Source: OSTI; NTIS; GPO Dep.

The general points being considered in the construction of equipment for the production of High Level Postum Gauzes were mentioned in the last progress report. A more detailed discussion of the progress to date will be made here. The development work of plating postum out of hydrofluoric acid has proceeded to the point where it is desired to make some runs plating out quantities of postum from 10–250 units per gauze. The following points have been considered in a report for limited distribution.

30059 (MLM–276) **Radioactive decontamination of metals by electropolishing.** Brodbeck, R.M.; Schommer, G.R. Mound, Miamisburg, OH (United States). 25 Jan 1949. 6p. Sponsored by USDOE, Washington, DC (United States). DOE Contract AC24-88DP43495. Order Number DE96001528. Source: OSTI; NTIS; GPO Dep.

Prior to April 1948 the generally accepted method of reducing the radioactive contamination of metal tools and laboratory apparatus was a series of rinses in aqua regia or various other concentrated acids. This method proved unsatisfactory for three reasons. (A) It was not a dependable method of removing activity. (B) It had a deleterious effect on tools in that it caused serious pitting, which resulted in weakened parts, and exposed a bare metal that was subject to very rapid corrosion. (C) Tools and apparatus once cleaned by this method could not readily be cleaned a second time. With the aforementioned limitations in mind, it became obvious that a new method was required. After considerable investigation into a electrochemical processes the present method was developed. Essentially, the new method is an electropolish bath to remove the activity lodged in the pores of the metal, and a "follow-up" chrome plate bath to render the surface impassive to corrosion.

30060 (MLM–282) **Preparation of bismuth powder.** Cox, G.C. Mound Lab., Miamisburg, OH (United States). 15 Feb 1949. 13p. Sponsored by USDOE, Washington, DC (United States). DOE Contract AC24-88DP43495. Order Number DE96001531. Source: OSTI; NTIS; GPO Dep.

The Purpose of this manual is to describe preparation of bismuth powder for use in process operations. Bismuth powder is to be prepared in Room 232 of "T" Building where all necessary apparatus is installed.

30061 (MLM–295) **Preparation of bismuth powder.** Cox, G.C.; Grasso, J.A.; Hale, D.; Wright, J.W. Mound Lab., Miamisburg, OH (United States). 8 Mar 1949. 36p. Sponsored by USDOE, Washington, DC (United States). DOE Contract AC24-88DP43495. Order Number DE96001593. Source: OSTI; NTIS; GPO Dep.

The principal object of this report is to record results of tests made on equipment installed in Room 232 of "T" Building and used to prepare bismuth powder for process operations. Another object is to establish the most favorable operating conditions for the equipment and to prepare operating instructions therefor.

30062 (ORNL–6874, pp. 65-76) **Cr_2Nb-based alloy development.** Liu, C.T. (Oak Ridge National Lab., TN (United States)); Tortorelli, P.F.; Horton, J.A. Oak Ridge National Lab., TN (United States). Jun 1995. DOE Contract AC05-84OR21400. In *Fossil Energy Program annual progress report for April 1994 through March 1995.* 203p. Order Number DE95015441. Source: OSTI; NTIS; GPO Dep.

The objective of this task is to develop a new generation of structural materials based on intermetallic alloys for use as critical hot components in advanced fossil energy conversion systems. The intermetallic phase, Cr_2Nb, with a complex cubic structure (C-15) has been selected for this development because of its high melting point (1770°C), relatively low material density (7.7 g/cm^2), excellent high-temperature strength (at 1000 to 1250°C), and potential resistance to oxidation and corrosion. This intermetallic phase, like many other Laves phases, has a wide range of compositional homogeneity suggesting the possibility of improving its mechanical and metallurgical properties by alloying additions. The major engineering concern with Cr_2Nb and other A_2B Laves phases is their poor fracture toughness and fracture resistance at ambient temperatures. The single-phase Cr_2Nb is very hard (~800 DPH) and brittle at room temperature. Because of this brittleness, the development effort has concentrated on two-phase structures containing the hard intermetallic phase Cr_2Nb and the softer Cr-rich solid solution phase. Potential applications of Cr-Cr_2Nb alloys include hot components (for example, air heat exchangers and turbine blades) in advanced energy conversion systems and heat engines, wear-resistant parts in coal handling systems (e.g., nozzles), drill bits for oil/gas wells, and valve guides in diesel engines. Current studies are focuses on enhancement of fracture resistance in tension at ambient temperatures and oxidation resistance above 1000°C. This report summarizes recent progress on controlling microstructure and improving the mechanical and metallurgical properties and the high-temperature corrosion behavior of Cr-Cr_2Nb alloys through alloying conditions, material processing, and heat treatment.

30063 (ORNL–6874, pp. 77-83) **Development of iron aluminides.** Viswanathan, S. (and others); Sikka, V.K.; Andleigh, V.K. Oak Ridge National Lab., TN (United States). Jun 1995. In *Fossil Energy Program annual progress report for April 1994 through March 1995.* 203p. Order Number DE95015441. Source: OSTI; NTIS; GPO Dep.

The primary reason for the poor room-temperature ductility of Fe_3Al-based alloys is generally accepted to be environmental embrittlement due to hydrogen produced by the reaction of aluminum with water vapor present in the test atmosphere. In the as-cast condition, another possible reason for the low room-temperature ductility is the large grain size (0.5 to 3 mm) of the cast material. While recent studies on iron aluminides in the wrought condition have led to higher room-temperature ductility and increased high-temperature strength, limited studies have been conducted on iron aluminides in the as-cast condition. The purpose of this study was to induce grain refinement of the as-cast alloy through alloying additions to the melt and study the effect on room-temperature ductility as measured by the strain corresponding to the maximum stress obtained in a three-point bend test. A base charge of Fe-28% Al-5% Cr alloy was used; as in previous studies this ternary alloy exhibited the highest tensile ductility of several alloys tested. Iron aluminide alloys are being considered for many structural uses, especially for applications where their excellent corrosion resistance is needed. Several alloy compositions developed at ORNL have been licensed to commercial vendors for development of scale-up procedures. With the licensees and other vendors, several applications for iron aluminides are being pursued.

30064 (ORNL–6874, pp. 85-89) **High-strength iron aluminide alloys.** McKamey, C.G.; Marrero-Santos, Y.; Maziasz, P.J. Oak Ridge National Lab., TN (United States). Jun 1995. In *Fossil Energy Program annual progress report for April 1994 through March 1995.* 203p. Order Number DE95015441. Source: OSTI; NTIS; GPO Dep.

Past studies have shown that binary Fe_3Al possesses low creep-rupture strength compared to many other alloys, with creep-rupture lives of less than 5 h being reported for tests conducted at 593°C and 207 MPa. The combination of poor creep resistance and low room-temperature tensile density due to a susceptibility to environmentally-induced dynamic hydrogen embrittlement has limited use of these alloys for structural applications, despite their excellent corrosion properties. Improvements in room temperature tensile ductility have been realized mainly through alloying effects, changes in thermomechanical processing to control microstructure, and by control of the specimen's surface condition. Ductilities of 10-20% and tensile yield strengths as high as 500 MPa have been reported. In terms of creep-rupture strength, small additions of Mo, Nb, and Zr have produced significant improvements, but at the expense of weldability and room-temperature tensile ductility. Recently an alloy containing these additions, designated FA-180, was

shown to exhibit a creep-rupture life of over 2000 h after a heat treatment of 1 h at 1150°C. This study presents the results of creep-rupture tests at various test temperatures and stresses and discusses the results as part of our effort to understand the strengthening mechanisms involved with heat treatment at 1150°C.

30065 (ORNL–6874, pp. 91-109) **Low-aluminum content iron-aluminum alloys.** Sikka, V.K. (and others); Goodwin, G.M.; Alexander, D.J. Oak Ridge National Lab., TN (United States). Jun 1995. In *Fossil Energy Program annual progress report for April 1994 through March 1995.* 203p. Order Number DE95015441. Source: OSTI; NTIS; GPO Dep.

The low-aluminum-content iron-aluminum program deals with the development of a Fe-Al alloy with aluminum content such as a produce the minimum environmental effect at room temperature. The FAPY is an Fe-16 at. % Al-based alloy developed at the Oak Ridge National Laboratory as the highest aluminum-containing alloy with essentially no environmental effect. The chemical composition for FAPY in weight percent is: aluminum = 8.46, chromium = 5.50, zirconium = 0.20, carbon = 0.03, molybdenum = 2.00, yttrium = 0.10 and iron = 83.71. The ignots of the alloy can be hot worked by extrusion, forging, and rolling processes. The hot-worked cast structure can be cold worked with intermediate anneals at 800°C. Typical room-temperature ductility of the fine-grained wrought structure is 20 to 25% for this alloy. In contrast to the wrought structure, the cast ductility at room temperature is approximately 1% with a transition temperature of approximately 100 to 150°C, above which ductility values exceed 20%. The alloy has been melted and processed into bar, sheet, and foil. The alloy has also been cast into slabs, step-blocks of varying thicknesses, and shapes. The purpose of this section is to describe the welding response of cast slabs of three different thicknesses of FAPY alloy. Tensile, creep, and Charpy-impact data of the welded plates are also presented.

30066 (ORNL–6874, pp. 123-135) **ODS iron aluminides.** Wright, I.G.; McKamey, C.G.; Pint, B.A. Oak Ridge National Lab., TN (United States). Jun 1995. In *Fossil Energy Program annual progress report for April 1994 through March 1995.* 203p. Order Number DE95015441. Source: OSTI; NTIS; GPO Dep.

There has been a recent increase of interest in advanced cycles that involve indirectly-fired gas turbines, in which coal- or gas-fired high-temperature heat exchangers are used to heat a working fluid in a closed system. In a program conducted as part of the European COST-501 Concerted Action Project, available alloys based on FeCrAl-Y_2O_3 were evaluated for use in the main heat exchanger in a similar closed-cycle gas turbine application. One of the currently available ODS FeCrAl alloys was found to meet the strength requirements for this application, in which the working fluid at 0.9 MPa (131 psi) flowing at 5,889 kg/hr (12,955 lb/hr) was to be heated from 800 to 1100°C (1472 to 2012°F) over a tube length of 4 m (13 ft).

30067 (ORNL–6874, pp. 137-146) **Mechanically reliable scales and coatings.** Tortorelli, P.F. (Oak Ridge National Lab., TN (United States)); Alexander, K.B. Oak Ridge National Lab., TN (United States). Jun 1995. DOE Contract AC05-84OR21400. In *Fossil Energy Program annual progress report for April 1994 through March 1995.* 203p. Order Number DE95015441. Source: OSTI; NTIS; GPO Dep.

In many high-temperature fossil energy systems, corrosion and deleterious environmental effects arising from reactions with reactive gases and condensible products often compromise materials performance and, as a consequence, degrade operating efficiencies. Protection of materials from such reactions is best afforded by the formation of stable surface oxides (either as deposited coatings or thermally grown scales) that are slowly reacting, continuous, dense, and adherent to the substrate. However, the ability of normally brittle ceramic films and coatings to provide such protection has long been problematical, particularly for applications involving numerous or severe high-temperature thermal cycles or very aggressive (for example, sulfidizing) environments. A satisfactory understanding of how scale and coating integrity and adherence are improved by compositional, microstructural, and processing modifications is lacking. Therefore, to address this issue, the present work is intended to define the relationships between substrate characteristics (composition, microstructure, and mechanical behavior) and the structure and protective properties of deposited oxide coatings and/or thermally grown scales. Such information is crucial to the optimization of the chemical, interfacial, and mechanical properties of the protective oxides on high-temperature materials through control of processing and composition and directly supports the development of corrosion-resistant, high-temperature materials for improved energy and environmental control systems.

30068 (ORNL/Sub–85-27421/07) **Weldability of polycrystalline aluminides. Topical report.** Fasching, A.A. (Colorado School of Mines, Golden, CO (United States)); Edwards, G.R.; David, S.A. Oak Ridge National Lab., TN (United States). Jul 1995. 90p. Sponsored by USDOE, Washington, DC (United States). DOE Contract AC05-84OR21400. Order Number DE95017710. Source: OSTI; NTIS; GPO Dep.

To investigate hydrogen cold cracking in iron aluminides and, specifically, to study the effect of fusion zone grain size on cracking susceptibility, welds were produced using magnetic arc oscillation to refine the fusion zone grain structures. Conventional welding produced extremely coarse columnar fusion zone grains (an average linear dimension of 530 micrometers) while welds produced with a magnetically oscillated arc contained equiaxed fusion zone grains averaging 115 micrometers in diameter. Slow strain rate tensile tests were conducted in varying water vapor atmospheres, on weldments with average fusion zone grain sizes ranging between 115 and 530 micrometers. Fracture strength and percent strain to fracture were measured for each fusion zone microstructure. The fracture strength increased in proportion to the inverse square root of the mean grain diameter, and decreased with increasing water vapor concentration. The results of the tensile tests showed that finer, equiaxed fusion zones were less susceptible to hydrogen cracking and more tolerant of high hydrogen concentrations than coarse fusion zone grain structures. Microstructural refinement via arc oscillation was also found to be suitable only for well-controlled fabrication environments.

30069 (ORNL/TM–12944) **Welding and mechanical properties of cast FAPY (Fe-16 at. % Al-based) alloy slabs.** Sikka, V.K.; Goodwin, G.M.; Alexander, D.J.; Howell, C.R. Oak Ridge National Lab., TN (United States). May 1995. 33p. Sponsored by USDOE, Washington, DC (United States). DOE Contract AC05-84OR21400. Order Number DE96000850. Source: OSTI; NTIS; GPO Dep.

This report deals with the welding procedure development and weldment properties of an Fe-16 at. % Al alloy known as FAPY. The welding procedure development was carried out on 12-, 25-, and 51-mm (0.5-, 1-, and 2-in.) -thick plates of the alloy in the as-cast condition. The welds were prepared by using the gas tungsten arc process and filler wire of composition matching the base-metal composition. The preheat temperatures varied from room temperature to 350°C, and the postweld heat treatment (PWHT) was limited only for 1 h at 750°C. The welds were characterized by microstructural. analysis and microhardness data. The weldment specimens were machined for Charpy-impact, tensile, and creep properties. The tensile and creep properties of the weldment specimens were essentially the same as that of the base metal. The Charpy-impact properties of the weldment specimens improved with the PWHT and were somewhat lower than previously developed data on the wrought material. Additional work is required on welding of thicker sections, development of PWHT temperatures as a function of section thickness, and mechanical properties.

30070 (ORNL/TM–12963, pp. 27-40) **Development of weldable, corrosion-resistant iron-aluminide alloys.** Maziasz, P.J. (Oak Ridge National Laboratory, TN (United States)); Goodwin, G.M.; Wang, X.L. Oak Ridge National Lab., TN (United States). May 1995. In *Advanced Industrial Materials (AIM) Program. Annual progress report, FY 1994.* 341p. Order Number DE95016129. Source: OSTI; NTIS; GPO Dep.

Corrosion-resistant, weldable FeAl alloys have been developed with improved high-temperature strength industrial applications. Previous processing difficulties with these alloys led to their evaluation as weld-overlay claddings on conventional structural steels to take advantage of their good properties now. Simplified and better processing methods for monolithic FeAl components are also currently being developed so that components for industrial testing

can be made. Other avenues for producing FeAl coatings are currently being explored. Neutron scattering experiments residual stress distributions in the FeAl weld-overlay cladding began in FY 1993 and continued this year.

30071 (ORNL/TM–12963, pp. 41-56) **Ni_3Al technology transfer.** Sikka, V.K. (Oak Ridge National Laboratory, TN (United States)); Santella, M.L.; Alexander, D.J. Oak Ridge National Lab., TN (United States). May 1995. In *Advanced Industrial Materials (AIM) Program. Annual progress report, FY 1994.* 341p. Order Number DE95016129. Source: OSTI; NTIS; GPO Dep.

Ductile Ni_3Al and Ni_3Al-based alloys have been identified for a range of applications. These applications require the use of material in a variety of product forms such as sheet, plate, bar, tubing, piping, and castings. Although significant progress has been made in the melting, casting, and near-net-shape forming of nickel aluminides, some issues still remain. These include the need for (1)high-strength castable composition for turbochargers, furnace furniture, and hot-die applications; (2) castability (fluidity, hot-shortness, porosity, etc.); (3) weld reparability of castings; and (4) hot fabricability of cast ingots. All of the issues listed above can be "show stoppers" for the commercial application of nickel aluminides. This report describes work completed to address some of these issues during the fourth quarter of FY 1994.

30072 (ORNL/TM–12963, pp. 57-74) **Precipitation-strengthening effects in iron-aluminides.** Maziasz, P.J. (Oak Ridge National Laboratory, TN (United States)); McKamey, C.G.; Goodwin, G.M. Oak Ridge National Lab., TN (United States). May 1995. In *Advanced Industrial Materials (AIM) Program. Annual progress report, FY 1994.* 341p. Order Number DE95016129. Source: OSTI; NTIS; GPO Dep.

The purpose of this work is to produce precipitation to improve both high-temperature strength and room-temperature ductibility in FeAl-type(B2 phase) iron-aluminides. Previous work has focused on primarily wrought products, but stable precipitates can also refine the grain size and affect the properties of as-cast and/or welded material as well. New work began in FY 1994 on the properties of these weldable, strong FeAl alloys in the as-cast condition. Because the end product of this project is components for industry testing, simpler and better (cheaper, near-net-shape) processing methods must be developed for industrial applications of FeAl alloys.

30073 (ORNL/TM–12963, pp. 75-86) **Superior metallic alloys through rapid solidification processing (RSP) by design.** Flinn, J.E. (Idaho National Engineering Laboratory, Idaho Falls, ID (United States)). Oak Ridge National Lab., TN (United States). May 1995. DOE Contract AC07-94ID13223. In *Advanced Industrial Materials (AIM) Program. Annual progress report, FY 1994.* 341p. Order Number DE95016129. Source: OSTI; NTIS; GPO Dep.

Rapid solidification processing using powder atomization methods and the control of minor elements such as oxygen, nitrogen, and carbon can provide metallic alloys with superior properties and performance compared to conventionally processing alloys. Previous studies on nickel- and iron-base superalloys have provided the baseline information to properly couple RSP with alloy composition, and, therefore, enable alloys to be designed for performance improvements. The RSP approach produces powders, which need to be consolidated into suitable monolithic forms. This normally involves canning, consolidation, and decanning of the powders. Canning/decanning is expensive and raises the fabrication cost significantly above that of conventional, ingot metallurgy production methods. The cost differential can be offset by the superior performance of the RSP metallic alloys. However, without the performance database, it is difficult to convince potential users to adopt the RSP approach. Spray casting of the atomized molten droplets into suitable preforms for subsequent fabrication can be cost competitive with conventional processing. If the fine and stable microstructural features observed for the RSP approach are preserved during spray casing, a cost competitive product can be obtained that has superior properties and performance that cannot be obtained by conventional methods.

30074 (ORNL/TM–12963, pp. 279-291) **Materials R&D-student internships.** Thompson, R.B. (Iowa State Univ., Ames, IA (United States)); Jiles, D.C.; Chumbley, L.S. Oak Ridge National Lab., TN (United States). May 1995. In *Advanced Industrial Materials (AIM) Program. Annual progress report, FY 1994.* 341p. Order Number DE95016129. Source: OSTI; NTIS; GPO Dep.

This program has as an objective the conduct of programmatic research for the Advanced Industrial Concepts Materials Program while training minority graduate students in the process. Well-known demographics indicate that minorities will constitute an increasing fraction of our future work force. Consequently, efforts have been initiated to increase the fraction of minorities and women who choose technical career paths. Included are a wide ranging set of programs beginning with pre-school education, progressing through efforts to retain students in technical paths in grades K-12 and undergraduate education, and ending with encouraging graduate education. The Materials R & D - Student Internships is a unique approach in the latter category. Here, we have focused on a particular area of applied materials research, the Advanced Industrial Concepts Materials Program. Our goal, then, is to educate minority graduate students in the context of this program. The Ames Laboratory was selected as a site for this pilot project since it is a DOE national laboratory, located on the campus of a major research university, which includes in its research interests programs with a strong technological flavor.

30075 (UCRL-CR–120464) **Survey of the degradation modes of candidate materials for high-level radioactive waste disposal containers.** Vinson, D.W. (Iowa State Univ. of Science and Technology, Ames, IA (United States)); Nutt, W.M.; Bullen, D.B. Lawrence Livermore National Lab., CA (United States); Iowa State Univ. of Science and Technology, Ames, IA (United States). Jun 1995. 148p. Sponsored by USDOE, Washington, DC (United States). DOE Contract W-7405-ENG-48. Order Number DE95015979. Source: OSTI; NTIS; INIS; GPO Dep.

Oxidation and atmospheric corrosion data suggest that addition of Cr provides the greatest improvement in oxidation resistance. Cr-bearing cast irons are resistant to chloride environments and solutions containing strongly oxidizing constituents. Weathering steels, including high content and at least 0.04% Cu, appear to provide adequate resistance to oxidation under temperate conditions. However, data from long-term, high-temperature oxidation studies on weathering steels were not available. From the literature, it appears that the low alloy steels, plain carbon steels, cast steels, and cast irons con-ode at similar rates in an aqueous environment. Alloys containing more than 12% Cr or 36% Ni corrode at a lower rate than plain carbon steels, but pitting may be worse. Short term tests indicate that an alloy of 9Cr-1Mo may result in increased corrosion resistance, however long term data are not available. Austenitic cast irons show the best corrosion resistance. A ranking of total corrosion performance of the materials from most corrosion resistant to least corrosion resistant is: Austenitic Cast Iron; 12% Cr = 36% Ni = 9Cr-1Mo; Carbon Steel = Low Alloy Steels; and Cast Iron. Since the materials to be employed in the Advanced Conceptual Design (ACD) waste package are considered to be corrosion allowance materials, the austenitic cast irons, high Cr steels, high Ni steels and the high Cr-Mo steels should not be considered as candidates for the outer containment barrier. Based upon the oxidation and corrosion data available for carbon steels, low alloy steels, and cast irons, a suitable list of candidate materials for a corrosion allowance outer barrier for an ACD waste package could include, A516, 2.25%Cr – 1%Mo Steel, and A27.

30076 (UCRL-CR–121663/S/C-B249873) **Acoustic-structure interaction problems. Final report.** Love, E.; Taylor, R.L. Lawrence Livermore National Lab., CA (United States). Dec 1993. 50p. Sponsored by USDOE, Washington, DC (United States). DOE Contract W-7405-ENG-48. Order Number DE96000852. Source: OSTI; NTIS; GPO Dep.

The purpose of this report is to compare and evaluate different numerical methods for solving problems of interaction between elastic solids and acoustic fluids. In particular, we concentrate our efforts on solution techniques involving the finite element method. To that end, in Chapter 2 we discuss different options for analysis of infinite fluids. In particular, the method of mesh trunction and the use of radiation elements and the use of infinite elements are discussed. Also discussed is the analysis of scattering from rigid

boundaries. Chapter 3 is a brief discussion of finite element formulations for elastic solids. We review the development, of two dimensional plane strain elements and one dimensional plate and shell elements. In Chapter 4, there is a discussion of the method used to couple the solid and the fluid. We give examples for solution of scattering of pressure waves from thin elastic shell structures. Chapter 5 is a brief conclusion of results and includes recommendations for the best methods of solution and additional research.

30077 (UCRL-ID–120392) **Localized weld metal corrosion in stainless steel water tanks.** Strum, M.J. Lawrence Livermore National Lab., CA (United States). 25 May 1995. 19p. Sponsored by USDOE, Washington, DC (United States). DOE Contract W-7405-ENG-48. Order Number DE95016054. Source: OSTI; NTIS; GPO Dep.

The rapidly developed leaks within the TFC and TFD tanks (LLNL groundwater treatment facilities) were caused by localized corrosion within the resolidified weld metal. The corrosion was initiated by the severe oxidation of the backsides of the welds which left the exposed surfaces in a condition highly susceptible to aqueous corrosion. The propagation of surface corrosion through the thickness of the welds occurred by localized corrosive attack. This localized attack was promoted by the presence of shielded aqueous environments provided by crevices at the root of the partial penetration welds. In addition to rapid corrosion of oxidized surfaces, calcium carbonate precipitation provided an additional source of physical shielding from the bulk tank environment. Qualification testing of alternate weld procedures showed that corrosion damage can be prevented in 304L stainless steel GTA welds by welding from both sides while preventing oxidation of the tank interior through the use of an inert backing gas such as argon. Corrosion resistance was also satisfactory in GMA welds in which oxidized surfaces were postweld cleaned by wire brushing and chemically passivated in nitric acid. Further improvements in corrosion resistance are expected from a Mo-containing grade of stainless steel such as type 316L, although test results were similar for type 304L sheet welded with type 308L filler metal and type 316L sheet welded with type 316L filler metal.

30078 (UCRL-JC–105760) **Implementation of a pressure and rate dependent Forming Limit Diagram model into NIKE and DYNA.** Logan, R.W. (Lawrence Livermore National Lab., CA (United States)); Thomas, D.B.; Young, G.K. Lawrence Livermore National Lab., CA (United States). Jun 1995. 20p. Sponsored by USDOE, Washington, DC (United States). DOE Contract W-7405-ENG-48. (CONF-951135–19: International mechanical engineering congress and exhibition - winter annual meeting of the American Society of Mechanical Engineers, San Francisco, CA (United States), 12-17 Nov 1995). Order Number DE96000085. Source: OSTI; NTIS; GPO Dep.

The Forming Limit Diagram (FLD) has been used for decades as an aid to successful sheet metal forming. In this work, we describe the incorporation of the FLD technique into the DYNA and NIKE codes at LLNL along with applications that led to the developments. The algorithm is currently available in the public version of DYNA3D. Several augmentations of the basic technique have been made available due to the necessity of their incorporation to solve programmatic problems of interest at LLNL. Illustration of the use of the FLD model is shown for a dome geometry similar to that used in the Limiting Dome Height (LDH) test. This early example uses the simplest FLD option (analogous to circle grid) and shows the relative merits of this method versus scalar plastic work in prediction of tearing. In a phenomenological extension of the method, a pressure-dependent (FLD+P) method is used to successfully predict the relative design merits of stainless steel forgings. A final application to sheet stamping of a Boeing 757 door frame shows how the scatter plot circle grid option and strain path plots can be used to predict when preforms and intermediate anneals are necessary. The phenomenological nature of the FLD model as implemented is discussed relative to alternative approaches of calculating the FLD and its path dependence.

30079 (UCRL-JC–116997) **The interaction of flow, heat transfer, and free interfaces in an electron-beam vaporization system for metals.** Westerberg, K.W. (Aspen Technology, Inc., Cambridge, MA (United States)); McClelland, M.A.; Finlayson, B.A. Lawrence Livermore National Lab., CA (United States). Nov 1994. 18p. Sponsored by USDOE, Washington, DC (United States). DOE Contract W-7405-ENG-48. (CONF-941128–8: Annual meeting of the American Institute of Chemical Engineers, San Francisco, CA (United States), 13-18 Nov 1994). Order Number DE96000090. Source: OSTI; NTIS; GPO Dep.

A numerical analysis is made of the liquid flow and energy transport in a system to vaporize metals. The energy from an electron beam heats metal confined in a water-cooled crucible. Metal vaporizes from a hot pool of circulating liquid which is surrounded by a shell of its own solid. Flow in the pool is strongly driven by temperature-induced buoyancy and capillary forces and is located in the transition region between laminar and turbulent flow. At high vaporization rates, the thrust of the departing vapor forms a trench at the beam impact site. A modified finite element method is used to calculate the flow and temperature fields coupled with the interface locations. The mesh is structured with spines that stretch and pivot as the interfaces move. The discretized equations are arranged in an "arrow" matrix and solved using the Newton-Raphson method. The electron-beam power and width are varied for cases involving the high-rate vaporization of aluminum. Attention is focused on the interaction of vaporization, liquid flow, and heat transport in the trench area.

30080 (UCRL-JC–118964) **Measuring enthalpies of formation using thick multilayer foils and differential scanning calorimetry.** Weihs, T.P.; Barbee, T.W. Jr.; Wall, M.A. Lawrence Livermore National Lab., CA (United States). 14 Apr 1995. 8p. Sponsored by USDOE, Washington, DC (United States). DOE Contract W-7405-ENG-48. (CONF-950412–35: Spring meeting of the Materials Research Society (MRS), San Francisco, CA (United States), 17-21 Apr 1995). Order Number DE95015884. Source: OSTI; NTIS; GPO Dep.

The ability to measure formation enthalpies of compounds at relatively low temperatures using thick multilayer foils and differential scanning calorimetry is demonstrated. Cu/Zr and Al/Zr multilayers were deposited onto Si and glass substrates using a planetary, magnetron source sputtering system. The as-deposited foils were removed from their substrates and heated from 50 to 725C in a differential scanning calorimeter (DSC). The Cu/Zr samples, which are all Cu-rich, showed three distinct, reproducible, and exothermic solid state reactions. The heats from the first two reactions were summed and analyzed to measure 14.3 ± 0.3 kJ/mol for $Cu_{51}Zr_{14}$'s enthalpy of formation. This quantity agrees with the single value of $\Delta H_f = 14.07 \pm 1.07$kJ/mol reported for this compound. The composition of the Al/Zr multilayers ranged from 8 at% Zr to 64 at% Zr. These samples showed a variety of distinct, reproducible, and exothermic solid state reactions. The total heats from these reactions were summed and analyzed to measure enthalpies of formation for five different Al-Zr alloys. The results compare favorably with literature values of ΔH_f. Advantages of measuring enthalpies of formation using thick multilayer foil samples and low temperature DSC calorimetry are discussed.

30081 (UCRL-JC–119956) **Energy absorption in aluminum extrusions for a spaceframe chassis.** Logan, R.W. (Lawrence Livermore National Lab., CA (United States)); Perfect, S.A.; Parkinson, R.D. Lawrence Livermore National Lab., CA (United States). 19 Sep 1994. 15p. Sponsored by USDOE, Washington, DC (United States). DOE Contract W-7405-ENG-48. (CONF-950455–2: 9. international conference on vehicle structural mechanics and computer-aided engineering, Troy, MI (United States), 4-6 Apr 1995). Order Number DE95017861. Source: OSTI; NTIS; GPO Dep.

This work describes the design, finite-element analysis, and verifications performed by LLNL and Kaiser Aluminum for the prototype design of the CALSTART Running Chassis purpose-built electric vehicle. Component level studies, along with our previous experimental and finite-element works, provided the confidence to study the crashworthiness of a complete aluminum spaceframe. Effects of rail geometry, size, and thickness were studied in order to achieve a controlled crush of the front end structure. These included the performance of the spaceframe itself, and the additive effects of the powertrain cradle and powertrain (motor/controller in

this case) as well as suspension. Various design iterations for frontal impact at moderate and high speed are explored.

30082 (UCRL-JC–120345) **An experimental method for investigating phase transformations in the heat affected zone of welds using synchrotron radiation.** Elmer, J.W.; Wong, J.; Froba, M.; Waide, P.A.; Larson, E.M. Lawrence Livermore National Lab., CA (United States). 26 May 1995. 7p. Sponsored by USDOE, Washington, DC (United States). DOE Contract W-7405-ENG-48. (CONF-950682–3: 4. international conference on trends in welding research, Gatlinburg, TN (United States), 5-9 Jun 1995). Order Number DE95015885. Source: OSTI; NTIS; GPO Dep.

Although welding is an established technology used in many industrial settings, it is least understand terms of the phases that actually exist, the variation of their spatial disposition with time, and the rate of transformation from one phase to another at various thermal coordinates in the vicinity of the weld. With the availability of high flux and, more recently, high brightness synchrotron x-radiation sources, a number of diffraction and spectroscopic methods have been developed for structural characterization with improved spatial and temporal resolutions to enable in-situ measurements of phases under extreme temperature, pressure and other processing conditions not readily accessible with conventional sources. This paper describes the application of spatially resolved x-ray diffraction (SRXRD) for in-situ investigations of phase transformations in the heat affected zone (HAZ) of fusion welds. Results are presented for gas tungsten (GTA) welds in commercially pure titanium that show the existence of the high temperature bcc β-phase in a 3.3 $\pm$ 0.3 mm wide HA band adjacent to the liquid weld pool. Phase concentration profiles derived from the SRXRD data further show the co-existence of both the low temperature hcp (α-phase and the β-phase in the partially, transformed region of the HA. These results represent the first direct observations of solid state phase transformations and mapping of phase boundaries in fusion welds. SRXRD experiments of this type are needed as experimental input for modeling of kinetics of phase transformations and microstructural evolution under the highly non-isothermal conditions produced during welding.

30083 (UCRL-JC–120702) **Industrial applications of high-power copper vapor lasers.** Warner, B.E.; Boley, C.D.; Chang, J.J.; Dragon, E.P.; Havstad, M.A.; Martinez, M.; McLean, W. II. Lawrence Livermore National Lab., CA (United States). 1 Aug 1995. 14p. Sponsored by USDOE, Washington, DC (United States). DOE Contract W-7405-ENG-48. (CONF-9508168–2: NATO advanced research workshop on pulsed metal vapor lasers, St. Andrews (United Kingdom), 7-11 Aug 1995). Order Number DE96000712. Source: OSTI; NTIS; GPO Dep.

A growing appreciation has developed in the last several years for the copper vapor laser because of its utility in ablating difficult materials at high rates. Laser ablation at high rates shows promise for numerous industrial applications such as thin film deposition, precision hole drilling, and machining of ceramics and other refractories.

30084 (UCRL-JC–121433) **Techniques for in situ HVEM mechanical deformation of nanostructural materials.** Wall, M.A.; Barbee, T.W. Jr.; Dahmen, U. Lawrence Livermore National Lab., CA (United States). 7 Aug 1995. 4p. Sponsored by USDOE, Washington, DC (United States). DOE Contract W-7405-ENG-48. (CONF-9508163–1: Microscopy Socity of America annual meeting, Kansas City, MO (United States), 14-18 Aug 1995). Order Number DE96000350. Source: OSTI; NTIS; GPO Dep.

We have developed two in-situ HVEM techniques which allow us to begin fundamental investigations into the mechanisms of deformation and fracture in nonstructured materials. A procedure for the observation of tensile deformation and failure in multilayers materials in cross-section is given and also the development of an in-situ HVEM nanoindentor of surfaces and films on surfaces in cross-section.

30085 (UCRL-JC–121758) **Crystal structure of actinide metals at high compression.** Fast, L. (Uppsala Univ. (Sweden). Physics Dept.); Soederlind, P. Lawrence Livermore National Lab., CA (United States). Aug 1995. 6p. Sponsored by USDOE, Washington, DC (United States). DOE Contract W-7405-ENG-48. (CONF-950846–61: American Physical Society biennial conference on shock compression of condensed matter, Seattle, WA (United States), 13-18 Aug 1995). Order Number DE96000104. Source: OSTI; NTIS; INIS; GPO Dep.

The crystal structures of some light actinide metals are studied theoretically as a function of applied pressure. The first principles electronic structure theory is formulated in the framework of density functional theory, with the gradient corrected local density approximation of the exchange-correlation functional. The light actinide metals are shown to be well described as itinerant (metallic) f-electron metals and generally, they display a crystal structure which have, in agreement with previous theoretical suggestions, increasing degree of symmetry and closed-packing upon compression. The theoretical calculations agree well with available experimental data. At very high compression, the theory predicts closed-packed structures such as the fcc or the hcp structures or the nearly closed-packed bcc structure for the light actinide metals. A simple canonical band picture is presented to explain in which particular closed-packed form these metals will crystallize at ultra-high pressure.

30086 (UCRL-MA–105268-Rev.1) **A nonlinear, implicit, three-dimensional finite element code for solid and structural mechanics - User's Manual.** Maker, B.N. Lawrence Livermore National Lab., CA (United States). 14 Apr 1995. 160p. Sponsored by USDOE, Washington, DC (United States). DOE Contract W-7405-ENG-48. Order Number DE96000381. Source: OSTI; NTIS (documentation only); ESTSC (complete software package), P.O. Box 1020, Oak Ridge, TN 37831-1020 (United States); GPO Dep.

This report provides a user's manual for NIKE3D, a fully implicit three-dimensional finite element code for analyzing the finite strain static and dynamic response of inelastic solids, shells, and beams. Spatial discretization is achieved by the use of 8-node solid elements, 2-node truss and beam elements, and 4-node membrane and shell elements. Over twenty constitutive models are available for representing a wide range of elastic, plastic, viscous, and thermally dependent material behavior. Contact-impact algorithms permit gaps, frictional sliding, and mesh discontinuities along material interfaces. Several nonlinear solution strategies are available, including Full-, Modified-, and Quasi-Newton methods. The resulting system of simultaneous linear equations is either solved iteratively by an element-by-element method, or directly by a factorization method, for which case bandwidth minimization is optional. Data may be stored either in or out of core memory to allow for large analyses.

30087 (UM-P–94/126) **{11-bar 01} twin dislocation structures in evaporated titanium thin films.** Bursill, L.A. (Melbourne Univ., Parkville, VIC (Australia). School of Physics); Peng, Julin; Fan, Xudong; Kasukabe, Y.; Yamada, Y. Melbourne Univ., Parkville, VIC (Australia). School of Physics. [1995]. 9p. Order Number DE96602540. Source: OSTI; NTIS; INIS.

High-resolution transmission electron micrographs of { 11-bar 01} interfacial twin dislocations in Ti thin films are reexamined. Computer simulations of the experimental images were obtained using atomic models deduced by Pond, Bacon and Serra (Phil Mag Letts, 1995). Two twin dislocations were analysed, with step heights of 4 x d(K_1) and 2 x d (K_1), where d(K_1) is the spacing of the { 11-bar 01 } planes. Reasonable agreement with the predicted structures was obtained at about 0.17nm resolution. 10 refs., 2 figs.

30088 (UM-P–94/129) **Observation and analysis of nanodomain textures in dielectric relaxor lead magnesium niobate.** Bursill, L.A.; Qian, Hua; Peng, Julin; Fan, X.D. Melbourne Univ., Parkville, VIC (Australia). School of Physics. [1995]. 45p. Sponsored by Australian Research Council, Canberra, ACT (Australia). Order Number DE96602541. Source: OSTI; NTIS; INIS.

High-resolution (0.2nm) images are used to locate chemical domains occurring with length scales of 1-5nm in the dielectric relaxor lead magnesium niobate (PMN). The experimental HRTEM images are analysed using computer-simulations and image matching in order to clarify and characterize the nature of the chemical ordering. Madelung electrostatic energy calculations are used to rank a set of structural models for possible ordered and disordered distributions of Nb and Mg over the B-sites of perovskite ABO_3. Next,

the chemical domain textures are modelled using next-nearest-neighbour Ising (NNNI) models and Monte Carlo methods. This results in a preferred model for the B-site distribution (the extended NNN-Ising model), which is used for image simulations. Both HRTEM many-beam bright-and dark-field and single-beam dark-field TEM images are obtained and compared with the experimental images. The final result is a realistic atomic model for the Nb, Mg distribution of PMN. 42 refs., 2 tabs., 10 figs.

30089 (Y–2469-3) **Y-12 development organization technical progress report, Part 3: Metal processing period ending March 1, 1995.** Northcutt, W.G. Jr. (comp.). Oak Ridge National Lab., TN (United States). [1995]. 14p. Sponsored by USDOE, Washington, DC (United States). DOE Contract AC05-84OS21400. Order Number DE96000400. Source: OSTI; NTIS; INIS; GPO Dep.

In an effort to integrate vertically the manufacturing processes at the Oak Ridge Centers for Manufacturing Technology (ORCMT) and at the same time obtain higher quality nickel-aluminium-bronze castings more quickly than outside sources were providing, a development program was started, addressing the problems of castings these types of components. Several small demonstration castings were made under vacuum and in graphite to assess the quality achievable by using this system.

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Refer also to citation(s) 28676, 29372, 29434, 29489, 29947, 29970, 30055, 30083, 30166, 30169, 30171, 30176, 30245, 30368, 30372, 31103, 31115, 31118, 31149

30090 (ANL/MSD/CP–83317) **Direct correlation of transport properties and microstructure in $Y_1Ba_2Cu_3O_{7-x}$ thin film grain boundaries.** Vuchic, B.V. (Argonne National Lab., IL (United States)); Merkle, K.L.; Buchholz, D.B.; Chang, R.P.H.; Marks, L.D. Argonne National Lab., IL (United States). Jul 1995. 7p. Sponsored by USDOE, Washington, DC (United States). DOE Contract W-31-109-ENG-38. (CONF-950412–45: Spring meeting of the Materials Research Society (MRS), San Francisco, CA (United States), 17-21 Apr 1995). Order Number DE95015825. Source: OSTI; NTIS; GPO Dep.

Individual 45° [0011] tilt grain boundaries in $Y_1Ba_2Cu_3O_{7-x}$ thin films grown on biepitaxial substrates were studied. The thin films were grown using both pulsed organometallic beam epitaxy (POMBE) and laser ablation. Transport characteristics of the individual grain boundaries were measured including resistance – temperature (R-T) and current – voltage (I-V) dependencies with and without an applied magnetic field. In order to elucidate possible structural origins of the differences in transport behavior, the same grain boundaries which were electrically characterized were subsequently thinned for electron-microscopy analysis. Transmission-electron-microscopy and high-resolution-electron-microscopy were used to structurally characterize the grain boundaries. The macroscopic and microscopic structures of two boundaries, a nominally resistive and a superconducting grain boundary, are compared. Work supported by the National Science Foundation Office of Science and Technology Centers, under contract #DMR 91-20000 (BVV, DBB) and the US Department of Energy, Basic Energy Sciences-Materials Science, under contract #W-31-109-EN(S-38 (KLM).

30091 (ANL/MSD/CP–85650) **Structure and transport properties of [001] tilt grain boundaries in $YBa_2Cu_3O_x$.** Miller, D.J. (Argonne National Lab., IL (United States)); Steel, D.G.; Yuan, F.; Hettinger, J.D.; Gray, K.E.; Talvacchio, J.; Kang, J.H. Argonne National Lab., IL (United States). [1995]. 4p. Sponsored by USDOE, Washington, DC (United States);National Science Foundation, Washington, DC (United States). DOE Contract W-31-109-ENG-38. DMR 91-20000. (CONF-950637–4: International workshop on superconductivity: controlled processing of high temperature superconductors - fundamentals and applications, Maui, HI (United States), 18-21 Jun 1995). Order Number DE95013735. Source: OSTI; NTIS; GPO Dep.

We have studied the microstructure and transport properties of nominal [001] tilt grain boundaries in order to correlate microstructural features with transport properties. single grain boundaries were prepared by epitaxial growth of $YBa_2Cu_3O_x$ onto bi-crystal $SrTiO_3$ substrates. Transport measurements were used to characterize the electrical behavior across the boundary while TEM was used to characterize the structure of the boundary. The transport measurements are consistent with grain boundary behavior, but detailed comparisons show anomalies which may be resolved by microstructural characterization. Microstructural characterization showed that these artificially induced grain boundaries are periodically decorated by impurity phases. In addition, the boundaries are not always straight, but instead frequently meander away from the path of the underlying boundary in the substrate, and the various facets produced by the meandering show varying degrees of tilt and twist character. These structural variations suggest one potential explanation for the reduced effective coupling area, although the correlation is not unambiguous.

30092 (CONF-950401–26) **Overview of ASTM standard activities in support of advanced structural ceramics development.** Brinkman, C.R. (Oak Ridge National Lab., TN (United States)); Quinn, G.D.; McClung, R.W. Oak Ridge National Lab., TN (United States). 1995. 15p. Sponsored by USDOE, Washington, DC (United States). DOE Contract AC05-84OR21400. From 97. annual meeting of the American Ceramic Society; Cincinnati, OH (United States); 30 Apr - 1 may 1995. Order Number DE95014044. Source: OSTI; NTIS; GPO Dep.

An overview is presented of the activities of ASTM Committee C-28 on Advanced Ceramics. This activity originated in 1986 when it became apparent that advanced ceramics were being considered for extensive use in applications such as advanced heat engines, heat exchangers, combustors, etc. in aerospace and energy conservation activities. These applications require optimum material behavior with physical and mechanical property reproducibility, component reliability, and well defined methods of data treatment and material analysis for both monolithic and composite ceramic materials. As new materials are introduced into the market place, these issues are best dealt with via standard methods. Therefore, a progress report is given describing activities of the five standard writing subcommittees who support the ASTM Committee C-28 effort. Accomplishments to date are given, as well as likely future activities, including a brief summary of joint cooperative efforts with international standard formulating organizations.

30093 (CONF-9505122–7) **Enhanced surface hardness in nitrogen-implanted silicon carbide.** Uslu, C. (Georgia Institute of Technology, Atlanta, GA (United States)); Lee, D.H.; Berta, Y. Oak Ridge National Lab., TN (United States). Jun 1995. 17p. Sponsored by USDOE, Washington, DC (United States);Georgia Inst. of Tech., Atlanta, GA (United States). DOE Contract AC05-84OR21400. From International conference on ion beam analysis; Tempe, AZ (United States); 22-26 May 1995. Order Number DE95017446. Source: OSTI; NTIS; GPO Dep.

Preliminary studies have been performed on the feasibility of carbon-silicon nitride formation (β-$Si_{1.5}C_{1.5}N_4$, the homologue of equilibrium β-Si_3N_4 or hypothetical β-C_3N_4) by high dose N^+-implantation into polycrystalline β-SiC (cubic). Thin films were formed using 100 keV implantations with varying ion doses in the range from 1.1×10^{17} to 27.1×10^{17} N/cm^2, and target temperatures between -196°C and 980°C. X-ray diffraction with a position-sensitive detector and cross-sectional transmission electron microscopy revealed that the as-implanted surfaces (up to 860°C) contained ~0.1 μm thick buried amorphous layers. Rutherford backscattering spectroscopy showed that the peak concentration of nitrogen saturated up to approximately 54 at. % with increasing doses, suggesting formation of a new phase. Implantation to doses of 1.1×10^{17} and 2.3×10^{17} N/cm^2 at 980°C caused enhanced surface hardness compared to SiC.

30094 (DOE/ER–0313/17, pp. 231-244) **Fabrication and performance testing of CaO insulator coatings on V-5%Cr-5%Ti in liquid lithium.** Park, J.H. (Argonne National Lab., Chicago, IL (United States)); Dragel, G. Oak Ridge National Lab., TN (United States). Apr 1995. In *Fusion materials semiannual progress report for the period ending September 30, 1994.* 390p. Order Number DE95013663. Source: OSTI; NTIS; INIS; GPO Dep.

Corrosion resistance of structural materials, and the magnetohydrodynamic (MHD) force and its influence on thermal hydraulics

and corrosion, are major concerns in the design of liquid-metal blankets for magnetic fusion reactors (MFRs). The objective of this study is to develop in-situ stable coatings at the liquid-metal/structural-material interface, with emphasis on coatings that can be converted to an electrically insulating film to prevent adverse currents that are generated by the MHD force from passing through the structural walls. The electrical resistance of CaO coatings produced on V-5Cr-5Ti by exposure of the alloy to liquid Li that contained 0.5 - 8.5 wt.% dissolved Ca was measured as a function of time at temperatures between 250 and 600°C. The solute element, Ca in liquid Li, reacted with the alloy substrate at 400-420°C to produce a CaO coating.

30095 (DOE/ER–0313/17, pp. 245-248) **Fabrication of aluminum nitride and its stability in liquid alkali metals.** Natesan, K. (Argonne National Lab., Chicago, IL (United States)); Rink, D.L. Oak Ridge National Lab., TN (United States). Apr 1995. In *Fusion materials semiannual progress report for the period ending September 30, 1994.* 390p. Order Number DE95013663. Source: OSTI; NTIS; INIS; GPO Dep.

The objective of this task are to (a) evaluate several fabrication procedures for development of aluminum nitride (AlN) coatings on the candidate first-wall structural material V-5wt.%Cr-5wt.%Ti, (b) evaluate the stability of coatings in contact with the structural alloy and liquid Li at temperatures of 200 to 400°C, (c) measure the electrical resistivity of the coated films after exposure to liquid Li, (d) evaluate the effects of coating defects on electrical resistivity, and (e) establish in-situ repair procedures to maintain adequate electrical insulating properties for the coatings.

30096 (DOE/ER–0313/17, pp. 267-273) **Fatigue crack growth rate (FCGR) behavior of nicalon/SiC composites.** Miriyala, N. (Univ. of Tennessee, Knoxville, TN (United States)); Liaw, P.K.; Yu, N. Oak Ridge National Lab., TN (United States). Apr 1995. In *Fusion materials semiannual progress report for the period ending September 30, 1994.* 390p. Order Number DE95013663. Source: OSTI; NTIS; INIS; GPO Dep.

The objective is to develop a fundamental understanding of fatigue crack growth phenomenon in Nicalon/SiC composites. Ultrasonic measurements were continued on the Nicalon/SiC composite specimens to correlate elastic moduli with percentage porosity in the in-plane as well as through-thickness directions. A micromechanics model based on periodic microstructure was developed to predict the elastic stiffness constants of the Nicalon/SiC composites. The predicted values were in good agreement with the experimental results.

30097 (DOE/ER–0313/17, pp. 331-345) **Effect of irradiation spectrum on the microstructural evolution in ceramic insulators.** Zinkle, S.J. (Oak Ridge National Lab., TN (United States)). Oak Ridge National Lab., TN (United States). Apr 1995. DOE Contract AC05-84OR21400. In *Fusion materials semiannual progress report for the period ending September 30, 1994.* 390p. Order Number DE95013663. Source: OSTI; NTIS; INIS; GPO Dep.

The objective of this study is to determine and examine the effect of variations in the ionizing and displacive radiation environments on the microstructure of oxide ceramic insulators. Cross section transmission electron microscopy has been used to investigate the microstructure of $MgAl_2O_4$ (spinel) and Al_2O_3 (alumina) following irradiation with ions of varying mass and energy at room temperature and 650°C. These results clearly indicate that light ion and electron irradiations produce microstructures which are not representative of the microstructure that would form in these ceramics during fission or fusion neutron irradiation.

30098 (DOE/ER–0313/17, pp. 346-349) **Data acquisition system used in radiation induced electrical degradation experiments.** White, D.P. (Oak Ridge National Lab., TN (United States)). Oak Ridge National Lab., TN (United States). Apr 1995. In *Fusion materials semiannual progress report for the period ending September 30, 1994.* 390p. Order Number DE95013663. Source: OSTI; NTIS; INIS; GPO Dep.

Radiation induced electrical degradation (RIED) of ceramic materials has recently been reported and is the topic of much research at the present time. The object of this report is to describe the data acquisition system for an experiment designed to study RIED at the High Flux Beam Reactor (HFBR) at Brookhaven National Laboratory.

30099 (DOE/ER–0313/17, pp. 350-361) **Cation disorder in high-dose, neutron-irradiated spinel.** Sickafus, K.E. (Los Alamos National Lab., CA (United States)); Larson, A.C.; Yu, N. Oak Ridge National Lab., TN (United States). Apr 1995. DOE Contract AC06-76RL01830. In *Fusion materials semiannual progress report for the period ending September 30, 1994.* 390p. Order Number DE95013663. Source: OSTI; NTIS; INIS; GPO Dep.

The objective of this effort is to determine whether $MgAl_2O_4$ spinel is a suitable ceramic for fusion applications. The crystal structures of $MgAl_2O_4$ spinel single crystals irradiated to high neutron fluences [$>5\times10^{26}$ n/m^2 ($E_n>0.1$ MeV)] were examined by neutron diffraction. Crystal structure refinement of the highese dose sample indicated that the average scattering strength of the tetrahedral crystal sites decreased by ≈20% while increasing by ≈8% on octahedral sites.

30100 (DOE/ER–0313/17, pp. 362-378) **Elastic stability of high dose neutron irradiated spinel.** Li, Z. (Argonne National Lab., Chicago, IL (United States)); Chan, S.K.; Garner, F.A. Oak Ridge National Lab., TN (United States). Apr 1995. In *Fusion materials semiannual progress report for the period ending September 30, 1994.* 390p. Order Number DE95013663. Source: OSTI; NTIS; INIS; GPO Dep.

The objective of this effort is to identify ceramic materials that are suitable for fusion reactor applications. Elastic constants (C_{11}, C_{12}, and C_{44}) of spinel ($MgAl_2O_4$) single crystals irradiated to very high neutron fluences have geen measured by an ultrasonic technique. Although results of a neutron diffraction study show that cation occupation sites are significantly changed in the irradiated samples, no measurable differences occurred in their elastic properties. In order to understand such behavior, the elastic properties of a variety of materials with either normal or inverse spinel structures were studied. The cation valence and cation distribution appear to have little influence on the elastic properties of spinel materials.

30101 (DOE/ER–0313/17, pp. 367-378) **Radiation-induced electrical degradation experiments in the Japan materials testing reactor.** Farnum, E. (Los Alamos National Lab., NM (United States)); Scharborough, K.; Shikama, Tatsuo. Oak Ridge National Lab., TN (United States). Apr 1995. In *Fusion materials semiannual progress report for the period ending September 30, 1994.* 390p. Order Number DE95013663. Source: OSTI; NTIS; INIS; GPO Dep.

The objective of this experiment is to determine the extent of degradation during neutron irradiation of electrical and optical properties of candidate dielectric materials. The goals are to identify promising dielectrics for ITER and other fusion machines for diagnostic applications and establish the basis for optimization of candidate materials. An experiment to measure radiation-induced electrical degradation (REID) in sapphire and MgO-insulated cables was conducted at the JMTR light water reactor. The materials were irradiated at about 260 °C to a fluence of 3×10^{24} n/m^2 (E>1 MeV) with an applied DC electric field between 100 kV/m and 500 kV/m.

30102 (DOE/ER/13987–T1) **Growth of high T_c superconducting fibers using a miniaturized laser-heated float zone process. Final technical report, January 15, 1989–December 31, 1994.** Feigelson, R.S.; Route, R.K.; DeMattei, R.C. Monsanto Research Corp., Miamisburg, OH (United States). Mound. Apr 1995. 109p. Sponsored by USDOE, Washington, DC (United States). DOE Contract FG03-89ER13987. (CMR–95-1). Order Number DE95017767. Source: OSTI; NTIS; GPO Dep.

This report summarizes a four year program on the use of the laser-heated pedestral growth (LHPG) process for the preparation of long, flexible fibers of the high T_c copper-oxide ceramic superconductors having wire-like morphology. The major question addressed was whether the LHPG method could produce high T_c fibers of $Bi_2Sr_2CaCu_2O_8$ (2212) in lengths long enough for use as superconducting wires. Cold-pressing and sintering methods were developed to prepare uniform, single phase ceramic feedstock. Phase equilibrium studies revealed the relationship between thermal gradients, interface shape and phases produced by the LHPG process during incongruent solidification. The highest critical current densities over measured in bulk samples of Bi-2212 material,

60,000 A/cm^2 at 68K, were achieved in single crystal and/or highly grain-oriented fibers. The first ever flexible, multi-cm fibers ($\leq$100 μm in diameter) were prepared. Fibers diameters were ultimately reduced to 25 μm (1 cm in length), and we were able to grow them up to 14 cm in length (100 μm diameter). These fibers could be bent in radii less than 5 cm, but max. growth rates of ~10 mm/hr did not permit them to be grown long enough for prototype motor windings. Superconducting Bi-2212 grain-aligned ribbons were grown for the first time by the LHPG method using platinum guide wires.

30103 (DOE/OR/21400–T480) **Friction and wear behavior of in-situ reinforced silicon nitride. Final report.** Yust, C.S. Oak Ridge National Lab., TN (United States). [1995]. 30p. Sponsored by USDOE, Washington, DC (United States). DOE Contract AC05-84OR21400. Order Number DE96000759. Source: OSTI; NTIS; GPO Dep.

Specimens of in-situ-reinforced silicon nitride (ISRSH) have been wear tested in lubricated, reciprocating, sliding motion against a silicon nitride counterface. Only mild wear of the ISRSN was observed at contact pressures up to 4.8 GPa at an average sliding velocity of 0.3 m/s. At 0.6 m/s, a wear mode transition was observed in ISRSN at 4.2 - 4.4 GPa. In comparison, the wear mode transition in silicon carbide whisker reinforced silicon nitride at both velocities was evident at about 2.2 - 2.4 GPa. Scanning electron microscopy of the ISRSN wear surfaces revealed the presence of a 40 pm thick debris layer on the mild wear tracks. The ISRSN wear mode transition response indicated a potential for an improved wear resistance in this material as compared to whisker reinforced silicon nitride.

30104 (DOE/OR/21400–T481) **Reciprocating sliding wear of in-situ reinforced silicon nitride.** Yust, C.S. Oak Ridge National Lab., TN (United States). [1995]. 20p. Sponsored by USDOE, Washington, DC (United States). DOE Contract AC05-84OR21400. Order Number DE96000760. Source: OSTI; NTIS; GPO Dep.

The reciprocating sliding wear response of two in-situ reinforced-silicon nitride compositions provided by AlliedSignal have been evaluated. The materials were prepared by AlliedSignal-Ceramic Components Division and were tested at conditions of interest to the Bendix Engine Controls Division (South Bend, IN) and AlliedSignal Research and Technology (Des Plaines, IL). The materials are being considered for a variety of new applications, and the current tests provide critical friction and wear values under anticipated operating conditions. Both pin and disk specimens of GS-44 and GN-10 in-situ reinforced silicon nitride of specified dimensions for wear testing were provided by the AlliedSignal participants. An initial series of tests examined the unlubricated behavior of these materials at elevated temperature (up to 900 C) in an inert atmosphere. The results revealed excessive levels of both friction and wear in the unlubricated condition. The test conditions were modified to include the use of jet fuel as a lubricant because of an intended application in that medium. The introduction of the lubricant resulted in very limited wear of both the pin and disk specimens.

30105 (DOE/OR/21400–T487) **Final report for the ORNL/3M CRADA No. ORNL91-0061 for the period January 1, 1992–December 31, 1992.** Weaver, B.L. (3M Company, St. Paul, MN (United States)); Besmann, T.M.; Lowden, R.A. Oak Ridge National Lab., TN (United States). [1995]. 10p. Sponsored by USDOE, Washington, DC (United States). DOE Contract AC05-84OR21400. Order Number DE96000668. Source: OSTI; NTIS; GPO Dep.

Oxide fiber-reinforced silicon carbide matrix composites were fabricated employing the forced-flow, thermal gradient chemical vapor infiltration (FCVI) process. Composites using Nextel™ fibers of varying composition were prepared to investigate the effectiveness of each Nextel™ fiber as a reinforcement for the given matrix. A carbon interface coating was used for the baseline materials, however, alternate interlayers with improved oxidation resistance were also explored. Room-temperature flexure strengths of as-fabricated composites and specimens heated in air at 1273 K were measured and compared to results for other SiC-matrix composites.

30106 (DOE/OR/21400–T490) **Comparison of properties of sintered and sintered reaction-bonded silicon nitride fabricated by microwave and conventional heating.** Tiegs, T.N. (and others); Kiggans, J.O. Jr.; Lin, H.T. Oak Ridge National Lab., TN (United States). [1995]. 8p. Sponsored by USDOE, Washington, DC (United States). DOE Contract AC05-84OR21400. Order Number DE96000671. Source: OSTI; NTIS; GPO Dep.

A comparison of microwave and conventional processing of silicon nitride-based ceramics was performed to identify any differences between the two, such as improved fabrication parameters or increased mechanical properties. Two areas of thermal processing were examined: sintered silicon nitride (SSN) and sintered reaction-bonded silicon nitride (SRBSN). The SSN powder compacts showed improved densification and enhanced grain growth. SRBSN materials were fabricated in the microwave with a one-step process using cost-effective raw materials. The SRBSN materials had properties appropriate for structural applications. Observed increases in fracture toughness for the microwave processed SRBSN materials were attributable to enhanced elongated grain growth.

30107 (EGG–11265-1120) **The growth and crystallography of bismuth tri-iodide crystals grown by vapor transport.** Nason, D. (EG and G Energy Measurements, Inc., Goleta, CA (United States). Santa Barbara Operations); Keller, L. EG and G Energy Measurements, Inc., Goleta, CA (United States). Santa Barbara Operations; CAMET Research, Inc., Goleta, CA (United States). [1995]. 17p. Sponsored by USDOE, Washington, DC (United States). DOE Contract AC08-93NV11265. Order Number DE96000160. Source: OSTI; NTIS; GPO Dep.

A single crystal of bismuth tri-iodide (BiI_3) of dimensions 1.2 x 1.2 x 0.4 cm^3 has been grown by physical vapor transport. The lattice parameters of the hexagonal crystal and its polycrystaleme powder precursor were measured by x-ray diffraction (XRD) and were in agreement, indicating that the vapor phase growth and sublimation purification processing at temperatures below 330°C did not significantly affect the stoichiometry. X-ray rocking measurements of the single crystal showed low angle boundaries of the order of 0.05°. In tests as gamma radiation detectors, neither melt grown nor vapor grown crystals were satisfactory, but the vapor grown crystals were promising. Several observations suggest that better performance may be achievable with purer bismuth tri-iodide.

30108 (IC–95/119) **Lithium hydride near melting point.** Islam, A.K.M.A. International Centre for Theoretical Physics, Trieste (Italy). Jun 1995. 9p. Order Number DE96601679. Source: OSTI; NTIS (US Sales Only); INIS.

The mechanical stability of LiH crystal is studied in this paper. The instability temperature T_e is found to lie above the observed melting point, in accord with computer simulation results of other materials. Several other features of LiH both in the solid and molten states are also discussed. (author). 22 refs, 4 figs.

30109 (INIS-BR–3541) **Preparation of lead titanate zirconate from metal citrates.** Bastos, C.M.R. UNESP, Araraquara, SP (Brazil). Inst. de Quimica. 1994. 233p. (In Portuguese). Order Number DE96602555. Source: OSTI; NTIS; INIS.

Lead titanate zirconate (PZT) preparation from its metal constituent citrates have been investigated. Metal citrates were obtained by forced precipitation using a dehydration alcohol mixture. Salt solutions of lead nitrate and octahydrated zirconyl chloride, and titanium tetrachloride were treated separately with citric acid and ammonium hydroxide. Zirconium, titanium and lead oxides resulted from thermal decomposition of corresponding citrates at 500^0 C, 450^0 C and 250^0 C, respectively. Lead titanate (PT) and lead zirconate (P Z) were obtained by calcining at 450^0 C and 500^0 C, respectively, after adequate heating of citrates mechanically mixed in ethyl ether. PZT samples were obtained with different starting stoichiometry. Rhombohedral PZT-1 53/47 sample was prepared from co precipitating zirconyl ammonium and ammonium lead citrates in presence of ethanolic titanium oxide dispersion, and calcinating at 800^0 C. Rhombohedral PZT-q 52/48 sample was obtained from heating at 500^0 C for 2 hours a mixture of metal citrates coprecipitated by dehydration mixture of acetone-ethanol-formic acid (2:1:0,06). Tetragonal PZT-m stoichiometry 53/47 sample were obtained by calcining at after 600^0 C for 2 hours after heating a mechanically mixed metal citrates. PT phase arose at 400^0 C. PZT-m powders obtained in a range of 400^0 C-800^0 C were

isostatically pressed, and sintered at 1100^0 C and 1200^0 C in saturated Pb O atmosphere. Rhombohedral sintered PZT was obtained with 7,78 $g.cm^{-3}$ at 1200^0 C. (author). 123 refs, 53 figs, 32 tabs.

30110 (INIS-mf–14589) **Preparation of uranium targets and application of analytical techniques for its evaluation.** Luna Z, D. Universidad Nacional Autonoma de Mexico, Mexico City (Mexico). Facultad de Quimica. 1994. 78p. (In Spanish). Order Number DE96602556. Source: OSTI; NTIS (US Sales Only); INIS.

The objective of this work is to establish a method to produce uranium targets. The method selected for this purpose was the molecular plating. The first part of this work is devoted to the proper selection of an analytical technique to evaluate the different steps of the molecular plating method. Neutron Activation Analysis was chosen, because its high sensitivity and can be adapted easily to follow the whole procedure. The second part presents the experimental procedure and the study of the different parameters involved in the molecular plating and the evaluation of its uniformity was made using plastic track detectors. The results obtained are presented and a procedure is suggested to produce uranium targets. (Author).

30111 (IS-M–828) **Oxidation resistance and compressive creep behavior of boron doped Mo_5Si_3.** Meyer, M.K. (Ames Lab., IA (United States)); Akinc, M.; Kramer, M.J. Ames Lab., IA (United States). [1995]. 10p. Sponsored by USDOE, Washington, DC (United States). (CONF-950894–3: International symposium on advanced ceramics for structural and tribological applications, Vancouver (Canada), 19-23 Aug 1995). Order Number DE96000210. Source: OSTI; NTIS; INIS; GPO Dep.

Use of Mo_5Si_3 in high temperature applications is limited by oxidation induced catastrophic failure above 800 C. Oxidation resistance of Mo_5Si_3 is substantially improved from 800–1,300 C by the addition of boron. The oxidation rate at 1,200 C was decreased by five orders of magnitude with less than 2 weight percent boron addition. The improvement in oxidation resistance of B doped Mo_5Si_3 is due to formation of a protective scale layer due to viscous flow. The compressive creep rate of B doped Mo_5Si_3 was measured at various temperature/stress levels and found to be similar to that of the undoped material. The creep rate of B doped Mo_5Si_3 was measured as 1.8×10^{-7} s^{-1} at 1,242 C and 138 MPa. Creep tests were conducted at 140–180 MPa and 1,220–1,320 C. Average creep activation energy and stress exponent in this range were found to be $E_a \approx 400$ kJ/mol and n = 4.3 respectively.

30112 (IS-M–829) **Effect of ternary additions on the oxidation resistance of Ti_5Si_3.** Thom, A.J. (Ames Lab., IA (United States)); Akinc, M. Ames Lab., IA (United States). [1995]. 8p. Sponsored by USDOE, Washington, DC (United States). DOE Contract W-7405-ENG-82. (CONF-950894–2: International symposium on advanced ceramics for structural and tribological applications, Vancouver (Canada), 19-23 Aug 1995). Order Number DE96000209. Source: OSTI; NTIS; INIS; GPO Dep.

Refractory intermetallic silicides are receiving increasing consideration for use as high temperature structural materials. Ti_5Si_3-based compositions are attractive due to their ability to incorporate a variety of interstitial ternary additions. These ternary additions present a unique opportunity to potentially tailor physical properties. Previous experimental work has shown that these additions significantly increase the otherwise poor oxidation resistance of undoped Ti_5Si_3 above 700 C. Recent experimental work by the authors on the oxidation of small atom doped Ti_5Si_3 is discussed. Interstitial additions of boron, carbon, and oxygen substantially improve the isothermal oxidation resistance of Ti_5Si_3 at 1,000 C. In contrast, added nitrogen does not provide significant improvement. Even up to 1,306 C, interstitial oxygen imparts excellent oxidation resistance with a mass gain of 1.1 mg/cm^2 after 240 hours.

30113 (IS-T–1723) **Magnetization studies of oxides related to the high temperature cuprate superconductors.** Wang, Z. Ames Lab., IA (United States). 19 Jun 1995. 131p. Sponsored by USDOE, Washington, DC (United States). DOE Contract W-7405-ENG-82. Order Number DE96000221. Source: OSTI; NTIS; GPO Dep.

The magnetic properties related to the following high temperature superconductors were measured utilizing a Faraday magnetometer: $BaCuO_{2+x}$, La_2CuO_4, Sr_2RhO_4, Sr_2VO_4, and Sr_2CuO_3. Neutron diffraction, magnetic susceptibility, and heat capacity measurements are discussed.

30114 (IS-T–1737) **Oxidation and creep behavior of Mo*5*Si*3* based materials.** Meyer, M. Ames Lab., IA (United States). 19 Jun 1995. 161p. Sponsored by USDOE, Washington, DC (United States). DOE Contract W-7405-ENG-82. Order Number DE96000219. Source: OSTI; NTIS; GPO Dep.

Mo_5Si_3 shows promise as a high temperature creep resistant material. The high temperature oxidation resistance of Mo_5Si_3 has been found to be poor, however, limiting its use in oxidizing atmospheres. Undoped Mo_5Si_3 exhibits mass loss in the temperature range 800°-1200°C due to volatilization of molybdenum oxide, indicating that the silica scale does not provide a passivating layer. The addition of boron results in protective scale formation and parabolic oxidation kinetics in the temperature range of 1050°-1300°C. The oxidation rate of Mo_5Si_3 was decreased by 5 orders of magnitude at 1200°C by doping with less than two weight percent boron. Boron doping eliminates catastrophic 'pest' oxidation at 800°C. The mechanism for improved oxidation resistance of boron doped Mo_5Si_3 is due to scale modification by boron.

30115 (LA-UR–95-2653) **Structure and properties of metal hydrides prepared by mechanical alloying.** Wasz, M.L.; Schwarz, R.B. Los Alamos National Lab., NM (United States). [1995]. 9p. Sponsored by USDOE, Washington, DC (United States). DOE Contract W-7405-ENG-36. (CONF-950798–1: International symposium on metastable, mechanically alloyed and nanocrystalline materials, Quebec City (Canada), 24-28 Jul 1995). Order Number DE95016965. Source: OSTI; NTIS; GPO Dep.

Our research examines the structure and reversible hydrogen storage capacity of alloys based on the $LaNi_5$ intermetallic. The alloys are prepared by mechanical alloying (MA), a technique particularly useful when alloying $LaNi_5$ with low melting point elements such as tin and calcium. In $LaNi_{5-y}Sn_y$, x-ray diffraction and Rietveld analysis show that tin preferentially occupies the Ni(3g) sites in the $LaNi_5$ structure, and the unit cell volume increases linearly with tin content to a maximum tin solubility of 7.33 atomic percent ($LaNi_{4.56}Sn_{0.44}$). The addition of tin to $LaNi_5$ causes (a) a logarithmic decrease in the plateau pressures for hydrogen absorption and desorption, which is consistent with the corresponding increase in the volume of the $LaNi_5$ unit cell; (b) a decrease in the hysteresis between the pressures for hydride formation and decomposition, which is in agreement with a recent theoretical model for the effect; and (c) a linear decrease in the hydrogen storage capacity. Effect (c) is explained by a rigid-band model whereby electrons donated by the tin atoms occupy holes in the 3d band of $LaNi_5$, which could otherwise be occupied by electrons donated by the hydrogen atoms. Thermodynamic van't Hoff analysis for these alloys show an increase in hydride formation enthalpy and no change in entropy with increasing tin concentration. $LaNi_5$ with calcium additions shows enhanced kinetics of hydrogen absorption/desorption. The powder particles prepared by MA have a larger surface area than particles of the same overall size prepared by arc casting. All $LaNi_5$-based alloys prepared by MA in an inert environment require no activation for hydrogen absorption and suffer less comminution upon hydriding/dehydriding.

30116 (LA-UR–95-2705) **Response of $CeRh_2Si_2$ to pressure.** Movshovich, R. (Los Alamos National Lab., NM (United States)); Hundley, M.F.; Thompson, J.D.; Smith, J.L.; Graf, T.; Mandrus, D.; Fisher, R.A. Los Alamos National Lab., NM (United States). [1995]. 15p. Sponsored by USDOE, Washington, DC (United States). DOE Contract W-7405-ENG-36. (CONF-9509209–1: International conference on strongly correlated electron systems, Goa (India), 27-30 Sep 1995). Order Number DE95016947. Source: OSTI; NTIS; INIS; GPO Dep.

Under atmospheric pressure, $CeRh_2Si_2$ orders antiferromagnetically at $T_N = 35$ K, with magnetic entropy $S = R\ell n2$ associated with the ordered groundstate. Application of modest pressure ($\approx$9 kbar) to $CeRh_2Si_2$ suppresses T_N to near zero Kelvin, increases its Sommerfeld coefficient of specific heat by nearly a factor of 3.5 and induces some form of superconductivity below 400 mK that is depressed by a magnetic field at a rate of −80 mK/kG.

30117 (LA-UR-95-3027) **Transport and magnetism correlations in thin-film ferromagnetic oxides.** Hundley, M.F.; Neumeier, J.J.; Heffner, R.H.; Jia, Q.X.; Wu, X.D.; Thompson, J.D. Los Alamos National Lab., NM (United States). [1995]. 13p. Sponsored by USDOE, Washington, DC (United States). DOE Contract W-7405-ENG-36. (CONF-951101-4: 40. conference on magnetism and magnetic materials, Philadelphia, PA (United States), 6-9 Nov 1995). Order Number DE96000069. Source: OSTI; NTIS; INIS; GPO Dep.

In order to determine the T_c-dependence of the colossal magnetoresistance (MR) exhibited by the ferromagnetic $La_{0.7}M_{0.3}MnO_{3+\sigma}$ (M = Ba, Ca, Sr) system, the authors examine the magnetic-field and temperature dependent resistivity and magnetization of a series of thin films that were grown via pulsed-laser deposition. The films had magnetic ordering temperatures (T_C) ranging from 150 to 350 K; all samples displayed a large negative MR that is largest near T_c. The magnitude of a given sample's MR at T_c inversely correlates with T_c; samples with a low T_c display significantly larger MR values than do samples with large T_c's. The quantity $\rho(T_c)/\rho(4$ K), the amount by which the resistivity is reduced by full ferromagnetic order, is an activated function of T_c with an activation energy E_a = 0.1 eV. These results indicate that the magnitude of the CMR effect in a given specimen is controlled not by $\rho(T_c)$, but by T_c via the ratio $\rho(T_c)/\rho(4$ K). Phenomenological scaling relationships are also reported that link $\rho(H,T)$ to both H and M(H, T).

30118 (LBL-36166) **Formation of metal oxides by cathodic arc deposition.** Anders, S.; Anders, A.; Rubin, M.; Wang, Z.; Raoux, S.; Kong, F.; Brown, I.G. Lawrence Berkeley Lab., CA (United States). Mar 1995. 20p. Sponsored by USDOE, Washington, DC (United States). DOE Contract AC03-76SF00098. (CONF-950454-9: 22. international AVS conference on metallurgical coatings and thin films, San Diego, CA (United States), 24-28 Apr 1995). Order Number DE96001122. Source: OSTI; NTIS; GPO Dep.

Metal oxide thin films are of interest for a number of applications. Cathodic arc deposition, an established, industrially applied technique for formation of nitrides (e.g. TiN), can also be used for metal oxide thin film formation. A cathodic arc plasma source with desired cathode material is operated in an oxygen atmosphere, and metal oxides of various stoichiometric composition can be formed on different substrates. We report here on a series of experiments on metal oxide formation by cathodic arc deposition for different applications. Black copper oxide has been deposited on ALS components to increase the radiative heat transfer between the parts. Various metal oxides such as tungsten oxide, niobium oxide, nickel oxide and vanadium oxide have been deposited on ITO glass to form electrochromic films for window applications. Tantalum oxide films are of interest for replacing polymer electrolytes. Optical waveguide structures can be formed by refractive index variation using oxide multilayers. We have synthesized multilayers of $Al_2O_3/Y_2O_3/Al_2O_3/Si$ as possible basic structures for passive optoelectronic integrated circuits, and $Al_{2-x}Er_xO_3$ thin films with a variable Er concentration which is a potential component layer for the production of active optoelectronic integrated devices such as amplifiers or lasers at a wavelength of 1.53 μm. Aluminum and chromium oxide films have been deposited on a number of substrates to impart improved corrosion resistance at high temperature. Titanium sub-oxides which are electrically conductive and corrosion resistant and stable in a number of aggressive environments have been deposited on various substrates. These sub-oxides are of great interest for use in electrochemical cells.

30119 (LBL-37091) **Plasma synthesis of alumina films on metal and ceramic substrates.** Brown, I.; Zhi Wang. Lawrence Berkeley Lab., CA (United States). Apr 1995. 8p. Sponsored by USDOE, Washington, DC (United States). DOE Contract AC03-76SF00098. (CONF-9505204-13: 9. annual conference on fossil energy materials, Oak Ridge, TN (United States), 16-18 May 1995). Order Number DE96000119. Source: OSTI; NTIS; GPO Dep.

The authors are exploring the feasibility of the plasma synthesis of highly-adherent films of alumina and chromia on SiC and FeAl substrates. A magnetically-filtered cathodic arc plasma deposition technique is used in which a high density metal plasma (Al or Cr) is formed and deposited on the substrate in the presence of a low pressure gaseous oxygen background. The substrate is simultaneously repetitively pulse biased, providing a means of controlling the incident ion energy. In the early stages of the process the ion energy is held in the keV range so as to produce atomic mixing at the film-substrate interface (ion stitching), and in the latter stages of deposition the energy is reduced to ~200 eV (IBAD range) to provide a means of controlling the film structure and morphology. Films that are dense and highly adherent can be formed in this way. The authors have produced near-stoichiometric films of alumina and chromia on small SiC and FeAl substrates and characterized the films in a number of ways, including RBS, X-ray diffraction and adhesion, and we've also done some preliminary temperature cycling experiments. The alumina films are of thickness from 0.2 to 1.5.μ, amorphous prior to heat treatment, and show an α-alumina phase after heat treating at 1,000 C for up to 16 hours. The film substrate adhesion is typically greater then ~70 MPa prior to heating, and initial results indicate that the films maintain their adhesion after repetitive cycling in temperature between ambient and 1,000 C. Here they describe the plasma processing method and outline the experimental results obtained to-date.

30120 (LBL-37449) **The growth of epitaxial iron oxides on platinum (111) as studied by X-ray photoelectron diffraction, scanning tunneling microscopy, and low energy electron diffraction.** Kim, Y.J. Lawrence Berkeley Lab., CA (United States). May 1995. 170p. Sponsored by USDOE, Washington, DC (United States):Department of Defense, Washington, DC (United States);National Energy Research Supercomputer Center (United States). DOE Contract AC03-76SF00098. Office of Naval Research Contract N00014-90-5-1457; Office of Na Order Number DE96000113. Source: OSTI; NTIS; GPO Dep.

Three complementary surface structure probes, x-ray photoelectron diffraction (XPD), scanning tunneling microscopy (STM), and low-energy electron diffraction (LEED) have been combined in a single instrument. This experimental system has been utilized to study the structure and growth mechanisms of iron oxide films on Pt(111); these films were formed by first depositing a single overlayer of Fe with a certain coverage in monolayers (ML's), and then thermally oxidizing it in an oxygen atmosphere. For films up to ~1 ML in thickness, a bilayer of Fe and O similar to those in FeO(111) is found to form. In agreement with prior studies, STM and LEED show this to be an incommensurate oxide film forming a lateral superlattice with short- and long-range periodicities of ~3.1 Å and ~26.0 Å. XPD in addition shows a topmost oxygen layer to be relaxed inward by -0.6 Å compared to bulk FeO(111), and these are new structural conclusions. The oxygen stacking in the FeO(111) bilayer is dominated by one of two possible binding sites. For thicker iron oxide films from 1.25 ML to 3.0 ML, the growth mode is essentially Stranski-Krastanov: iron oxide islands form on top of the FeO(111) bilayer mentioned above. For iron oxide films of 3.0 ML thickness, x-ray photoelectron spectroscopy (XPS) yields an Fe $2p_{3/2}$ binding energy and an Fe:O stoichiometry consistent with the presence of Fe_3O_4. Our XPD data further prove this overlayer to be Fe_3O_4(111)-magnetite in two almost equally populated domains with a 180° rotation between them. The structural parameters for this Fe_3O_4 overlayer generally agree with those of a previous LEED study, except that we find a significant difference in the first Fe-O interplanar spacing. This work demonstrates the considerable benefits to be derived by using this set of complementary surface structure probes in such epitaxial growth studies.

30121 (LBL-37487) **Feasibility of synthesizing oxide films on ceramic and metal substrates. Final report, August 1994-May 1995.** Brown, I.G. (Lawrence Berkeley Lab., CA (United States)). Oak Ridge National Lab., TN (United States); Lawrence Berkeley Lab., CA (United States). Jul 1995. 12p. Sponsored by USDOE, Washington, DC (United States). DOE Contract AC03-76SF00098 ; AC05-84OR21400. (ORNL/Sub-94-SS109/01). Order Number DE95017558. Source: OSTI; NTIS; GPO Dep.

Feasibility of synthesizing highly adherent alumina and chromia films on SiC and FeAl substrates using plasma methods was studied. A magnetically filtered, cathodic-arc-produced, metal plasma (Al or Cr) is deposited on the substrate in presence of low pressure oxygen while the substrate is repetitively pulse biased for control of incident ion energy. In the early stages, the ion energy is held in the

keV range to produce atomic mixing at the film-substate interface (ion stitching); in the latter stages, the energy is reduced to about 200 eV (IBAD, or ion beam assisted deposition, range) to control the film structure and morphology. Near-stoichiometric films of alumina and chromia were formed on small SiC and FeAl substrates and characterized by RBS, XRD, adhesion, and temperature cycling. The aluminia films were 0.2 to 1.5 μ thick, were amorphous prior to heat treatment, and showed an α-alumina phase after heat treating at 1000 C for up to 16 h. Film substrate adhesion was typically greater than 70 MPa prior to heating, and the thinner films maintained their adhesion even after repetitive cycling in temperature between ambient and 1000 C. It is concluded that the plasma and ion beam techniques developed provide important tools for forming highly adherent and thermally tolerant ceramic films.

30122 (ORNL–6874, pp. 17-19) **Oxide coating development.** Stinton, D.P. Oak Ridge National Lab., TN (United States). Jun 1995. In *Fossil Energy Program annual progress report for April 1994 through March 1995.* 203p. Order Number DE95015441. Source: OSTI; NTIS; GPO Dep.

Monolithic SiC heat exchangers and fiber-reinforced SiC-matrix composite heat exchangers and filters are susceptible to corrosion by alkali metals at elevated temperatures. Protective coatings are currently being developed to isolate the SiC materials from the corrodants. Unfortunately, these coatings typically crack and spall when applied to SiC substrates. The purpose of this task is to determine the feasibility of using a compliant material between the protective coating and the substrate. The low-modulus compliant layer could absorb stresses and eliminate cracking and spalling of the protective coatings.

30123 (ORNL–6874, pp. 21-33) **Development of oxidation/corrosion-resistant composite materials and interfaces.** Stinton, D.P. (and others); Besmann, T.M.; Shanmugham, S. Oak Ridge National Lab., TN (United States). Jun 1995. In *Fossil Energy Program annual progress report for April 1994 through March 1995.* 203p. Order Number DE95015441. Source: OSTI; NTIS; GPO Dep.

Continuous fiber ceramic composites (CFCCs) are being developed for high temperature structural applications, many of which are in oxidative environments. Such composites are attractive since they are light-weight and possess the desired mechanical properties at elevated temperature and in aggressive environments. The most significant advantage is their toughness and their non-catastrophic failure behavior. The mechanical properties of CFCCs have been characteristically linked with the nature of the interfacial bond between the fibers and the matrix. Weakly bonded fiber-matrix intefaces allow an impinging matrix crack to be deflected such that the fracture process occurs through several stages: Crack deflection, debonding at the interface, fiber slip and pull-out, and ultimately fiber failure. Such a composite will fail in a graceful manner and exhibit substantial fracture toughness. Currently, carbon interface coatings are used to appropriately tailor interface properties, however their poor oxidation resistance has required a search of an appropriate replacement. Generally, metal oxides are inherently stable to oxidation and possess thermal expansion coefficients relatively close to those of Nicalon and SiC. However, the metal oxides must also be chemically compatible with the fiber and matrix. If the fiber/interface/matrix system is chemically compatible, then the interfacial bonding stress is influenced by the thermal residual stresses that are generated as the composite is cooled from processing to room temperature. In the current work, thermomechanical computational results were obtained from a finite element model (FEM) for calculating the thermal residual stresses. This was followed by experimental evaluation of Nicalon/SiC composites with carbon, alumina, and mullite interfacial coatings.

30124 (ORNL/M–4079) **Development of microwave processing of silicon nitride components for advanced heat engine applications -- Microwave annealing of silicon nitride with high additive contents. CRADA final report for CRADA Number ORNL90-0035.** Tiegs, T.N. Oak Ridge National Lab., TN (United States). 6 Dec 1994. 8p. Sponsored by USDOE, Washington, DC (United States). DOE Contract AC05-84OR21400. Order Number DE96000761. Source: OSTI; NTIS; GPO Dep.

The initial work on microwave annealing of dense silicon nitride showed enhanced grain growth and improved creep resistance for materials annealed at temperatures of 1,200–1500 C. In those tests, the anneal times were on the order of 10–20 h to achieve the observed changes. To further study the effectiveness of microwave annealing, a Cooperative Research and Development Agreement (CRADA) was started in the area of microwave processing of silicon nitride with Garrett Ceramic Components/Allied-Signal (GCC/AS). The original plan was for ORNL to microwave anneal specimens of dense silicon nitride with high additive contents (> 5%) provided by GCC/AS at various times and temperatures. There were to be three sample types and 3–4 annealing conditions for a total of 9–12 annealing runs. The materials would then be characterized by both ORNL and GCC/AS to determine any changes in the properties. The objectives were: (1) to determine the effects of microwave crystallization on mechanical properties, and (2) to compare the effectiveness of microwave versus conventional heating. The mechanical properties examined that were fracture toughness, flexural strength and high temperature stress rupture. Delays, organizational changes, and other commercialization priorities resulted in a termination of this CRADA. This report contains a summary of results from one silicon nitride composition.

30125 (ORNL/TM–12924) **Ceramic technology report. Semi-annual progress report, April 1994–September 1994.** Johnson, D.R. Oak Ridge National Lab., TN (United States). Jun 1995. 461p. Sponsored by USDOE, Washington, DC (United States). DOE Contract AC05-84OR21400. Order Number DE96000294. Source: OSTI; NTIS; GPO Dep.

The Ceramic Technology Project was originally developed by the Department of Energy's Office of Transportation Systems (OTS) in Energy Efficiency and Renewable Energy. This project, part of the OTS's Materials Development Program, was developed to meet the ceramic technology requirements of the OTS's automotive technology programs. Significant accomplishments in fabricating ceramic components for the Department of Energy (DOE), National Aeronautics and Space Administration (NASA), and Department of Defense (DoD) advanced heat engine programs have provided evidence that the operation of ceramic parts in high-temperature engine environments is feasible. However, these programs have also demonstrated that additional research is needed in materials and processing development, design methodology, and data base and life prediction before industry will have a sufficient technology base from which to produce reliable cost-effective ceramic engine components commercially. In response to extensive input from industry, the plan is to extend the engine types which were previously supported (advanced gas turbine and low-heat-rejection diesel engines) to include near-term (5-10 years) applications in conventional automobile and diesel truck engines. To facilitate the rapid transfer of this technology to U.S. industry, the major portion of the work is being done in the ceramic industry, with technological support from government laboratories, other industrial laboratories, and universities. A systematic approach to reducing the cost of components is envisioned. The work elements are as follows: economic cost modeling, ceramic machining, powder synthesis, alternative forming and densification processes, yield improvement, system design studies, standards development, low-expansion ceramics, and testing and data base development.

30126 (ORNL/TM–12963, pp. 87-124) **Synthesis and design of intermetallic materials - molybdenum disilicide.** Petrovic, J.J. (Los Alamos National Laboratory, NM (United States)); Castro, R.G.; Butt, D.P. Oak Ridge National Lab., TN (United States). May 1995. In *Advanced Industrial Materials (AIM) Program. Annual progress report, FY 1994.* 341p. Order Number DE95016129. Source: OSTI; NTIS; GPO Dep.

The objective of this program is to develop structural silicide-based composite materials with optimum combinations of elevated temperature strength/creep resistance, low temperature fracture toughness, and high temperature oxidation resistance for applications of importance to the U.S. processing industry. A further objective is to develop silicide-based prototype industrial components. The ultimate aim of the program is to work with industry to transfer the structural silicide materials technology to the private sector in order to promote international competitiveness in the area of advanced high temperature composite materials and important applications in major energy-intensive U.S. processing industries.

The program presently has a number of developing industrial connections, including a CRADA with the advanced materials company Advanced Refractory Technologies Inc. and interactions targeted at developing industrial gas burner and metal and glass melting/processing applications. Current experimental emphasis is on the development and characterization of SiC reinforced-$MoSi_2$ matrix composites, plasma sprayed $MoSi_2$-based materials and microlaminate composites, and $MoSi_2$ reinforced-Si_3N_4 matrix composites. We are developing processing methods for $MoSi_2$-based materials and microlaminate composites, and $MoSi_2$ reinforced-Si_3N_4 matrix composites. We are developing processing methods for $MoSi_2$-based materials, such as plasma spraying/spray forming and electrophoretic deposition. We are also pursuing the fabrication of prototype industrial gas burner and injection tube components of these materials, as well as prototype components for glass processing.

30127 (ORNL/TM–12963, pp. 127-135) **Advanced methods for processing ceramics.** Carter, W.B. (Georgia Institute of Technology, Atlanta, GA (United States)). Oak Ridge National Lab., TN (United States). May 1995. In *Advanced Industrial Materials (AIM) Program. Annual progress report, FY 1994.* 341p. Order Number DE95016129. Source: OSTI; NTIS; GPO Dep.

Combustion chemical vapor deposition (CCVD) is a flame assisted, open air chemical vapor deposition (CVD) process. The process is capable of producing textured, epitaxial coatings on single crystal substrates using low cost reagents. Combustion chemical vapor deposition is a relatively inexpensive, alternative thin film deposition process with potential to replace conventional coating technologies for certain applications. The goals of this project are to develop the CCVD process to the point that potential industrial applications can be identified and reliably assessed.

30128 (ORNL/TM–12963, pp. 143-148) **Characterization of CVI densification of ceramic composites.** Starr, T.L. (Georgia Institute of Technology, Atlanta. GA (United States)); Stock, S.R.; Lee, S. Oak Ridge National Lab., TN (United States). May 1995. Subcontract 19X-SL260C. In *Advanced Industrial Materials (AIM) Program. Annual progress report, FY 1994.* 341p. Order Number DE95016129. Source: OSTI; NTIS; GPO Dep.

Ceramic matrix composites promise higher operating temperature and better thermodynamic efficiency in many enregy conversion systems. In particular, composites fabricated by the chemical vapor infiltration (CVI) process have excellent mechanical properties and, using the forced flow-thermal gradient variation, good processing economics in small scale demonstrations. Scale-up to larger, more complex shapes requires understanding of gas flow through the fiber preform and of the relationship between fiber architecture and densification behavior. This understanding is needed for design of preforms for optimum infiltration. The objective of this research is to observe the deposition of matrix material in the pores of a ceramic fiber preform at various stages of the CVI process. These observations allow us to relate local deposition rates in various regions of the composite to the connectivity of the surrounding network of porosity and to better model the relationship between gas transport and fiber architecture in CVI preforms. Our observation of the CVI process utilizes high resolution X-ray tomographic microscopy (XTM) in collaboration with Dr. John Kinney at Lawrence Livermore National Laboratory with repeated imaging of a small preform specimens after various processing times. We use these images to determine geometry and dimensions of channels between and through layers in cloth lay-up preform during CVI densification and relate these to a transport model.

30129 (ORNL/TM–12963, pp. 149-156) **Characterization of three-way automotive catalysts.** Kenik, E.A. (Oak Ridge National Laboratory, TN (United States)); More, K.L.; LaBarge, W. Oak Ridge National Lab., TN (United States). May 1995. In *Advanced Industrial Materials (AIM) Program. Annual progress report, FY 1994.* 341p. Order Number DE95016129. Source: OSTI; NTIS; GPO Dep.

This has been the second year of a CRADA between General Motors - AC Delco Systems (GM-ACDS) and Martin Marietta Energy Systems (MMES) aimed at improved performance/lifetime of platinum-rhodium based three-way-catalysts (TWC) for automotive emission control systems. While current formulations meet existing emission standards, higher than optimum Pt-Rh loadings are often required. In additionk, more stringent emission standards have been imposed for the near future, demanding improved performance and service life from these catalysts. Understanding the changes of TWC conversion efficiency with ageing is a critical need in improving these catalysts.

30130 (ORNL/TM–12963, pp. 157-161) **Chemical vapor infiltration of TiB_2 composites.** Besmann, T.M. (Oak Ridge National Laboratory, TN (United States)). Oak Ridge National Lab., TN (United States). May 1995. In *Advanced Industrial Materials (AIM) Program. Annual progress report, FY 1994.* 341p. Order Number DE95016129. Source: OSTI; NTIS; GPO Dep.

This program is designed to develop a Hall-Heroult aluminum smelting cathode with substantially improved properties. The carbon cathodes in current use require significant anode-to-cathode spacing in order to prevent shorting, causing significant electrical inefficiencies. This is due to the non-wettability of carbon by aluminum which causes instability in the cathodic aluminum pad. It is suggested that a fiber reinforced-TiB_2 matrix composite would have the requisite wettability, strength, strain-to-failure, cost, and lifetime to solve this problem. The approach selected to fabricate such a cathode material is chemical vapor infiltration (CVI). This program is designed to evaluate potential fiber reinforcements, fabricate test specimens, and test the materials in a static bath and lab-scale Hall cell.

30131 (ORNL/TM–12963, pp. 163-170) **High-deposition-rate ceramics synthesis.** Allendorf, M.D. (Sandia National Laboratories, Livermore, CA (United States)); Osterheld, T.H.; Outka, D.A. Oak Ridge National Lab., TN (United States). May 1995. In *Advanced Industrial Materials (AIM) Program. Annual progress report, FY 1994.* 341p. Order Number DE95016129. Source: OSTI; NTIS; GPO Dep.

Parallel experimental and computational investigations are conducted in this project to develop validated numerical models of ceramic synthesis processes. Experiments are conducted in the High-Temperature Materials Synthesis Laboratory in Sandia's Combustion Research Facility. A high-temperature flow reactor that can accommodate small preforms (1-3 cm diameter) generates conditions under which deposition can be observed, with flexibility to vary both deposition temperature (up to 1500 K) and pressure (as low as 10 torr). Both mass spectrometric and laser diagnostic probes are available to provide measurements of gas-phase compositions. Experiments using surface analytical techniques are also applied to characterize important processes occuring on the deposit surface. Computational tools developed through extensive research in the combustion field are employed to simulate the chemically reacting flows present in typical industrial reactors. These include the CHEMKIN and Surface-CHEMKIN suites of codes, which permit facile development of complex reaction mechanisms and vastly simplify the implementation of multi-component transport and thermodynamics. Quantum chemistry codes are also used to estimate thermodynamic and kinetic data for species and reactions for which this information is unavailable.

30132 (ORNL/TM–12963, pp. 171-177) **Metallic and intermetallic-bonded ceramic composites.** Plucknett, K.P. (Oak Ridge National Laboratory, TN (United States)); Tiegs, T.N.; Alexander, K.B. Oak Ridge National Lab., TN (United States). May 1995. In *Advanced Industrial Materials (AIM) Program. Annual progress report, FY 1994.* 341p. Order Number DE95016129. Source: OSTI; NTIS; GPO Dep.

The purpose of this task is to establish a framework for the development and fabrication of metallic-phase-reinforced ceramic matrix composites with improved fracture toughness and damage resistance. The incorporation of metallic phases that plastically deform in the crack tip region, and thus dissipate strain energy, will result in an increase in the fracture toughness of the composite as compared to the monolithic ceramic. It is intended that these reinforced ceramic matrix composites will be used over a temperature range from 20°C to 800-1200°C for advanced applications in the industrial sector. In order to systematically develop these materials, a combination of experimental and theoretical studies must be undertaken.

30133 (ORNL/TM–12963, pp. 179-193) **Microwave and RF assisted chemical vapor infiltration.** Devlin, D.J. (Los Alamos National Laboratory, NM (United States)); Barbero, R.S. Oak Ridge National Lab., TN (United States). May 1995. In *Advanced Industrial Materials (AIM) Program. Annual progress report, FY 1994.* 341p. Order Number DE95016129. Source: OSTI; NTIS; GPO Dep.

Work during this reporting period has focused on the development of a CVI technique for rapid production of carbon/carbon and alumina composite systems. The focus of the alumina effort is towards porous materials for membrane supports and hot gas filtration. Industrial interest in these applications include companies such as: Dow, Westinghouse, Amoco and DuPont. Applications for the carbon materials are numerous and include: brakes, sporting goods, biomedical materials, flaps and seals for thrust control, after burner nozzles, turbine engine flaps and rotors. This effort will focus on aircraft brakes. A collaboration is underway with Hitco a major producer of carbon/carbon materials.

30134 (ORNL/TM–12963, pp. 195-215) **Synthesis and processing of composites by reactive metal penetration.** Loehman, R.E. (Sandia National Laboratories, Albuquerque, NM (United States)); Ewsuk, K.G.; Tomsia, A.P. Oak Ridge National Lab., TN (United States). May 1995. In *Advanced Industrial Materials (AIM) Program. Annual progress report, FY 1994.* 341p. Order Number DE95016129. Source: OSTI; NTIS; GPO Dep.

Ceramic-metal composites are being developed because their high stiffness-to weight ratios, good fracture toughness, and variable electrical and thermal properties give them advantages over more conventional materials. However, because ceramic-metal composite components presently are more expensive than monolithic materials, improvements in processing are required to reduce manufacturing costs. Reactive metal penetration is a promising new method for making ceramic- and metal-matrix composites that has the advantage of being inherently a net-shape process. This technique, once fully developed, will provide another capability for manufacturing the advanced ceramic composites that are needed for many light-weight structural and wear applications. The lower densities of these composites lead directly to energy savings in use. Near-net-shape fabrication of composite parts should lead to additional savings because costly and energy intensive grinding and machining operations are significantly reduced, and the waste generated from such finishing operations is minimized. The goals of this research program are: (1) to identify feasible compositional systems for making composites by reactive metal penetration; (2) to understand the mechanism(s) of composite formation by reactive metal penetration; and (3) to learn how to control and optimize reactive metal penetration for economical production of composites and composite coatings.

30135 (ORNL/TM–12963, pp. 217-226) **Three-dimensional x-ray tomography of crack-resistant composites: New paradigms for process optimization.** Kinney, J.H. (Lawrence Livermore National Laboratory, CA (United States)); Haupt, D.L. Oak Ridge National Lab., TN (United States). May 1995. In *Advanced Industrial Materials (AIM) Program. Annual progress report, FY 1994.* 341p. Order Number DE95016129. Source: OSTI; NTIS; GPO Dep.

The goal of this research is to apply noninvasive, volumetric imaging technology (the x-ray tomographic microscope) to the characterization and process-modeling of ceramic matrix composites. Specifically, we propose to follow the evolution of a composite's microstructure during chemical vapor infiltration processing, and relate the microstructure to processing parameters and fiber architecture. The results will be used to provide the fundamental and practical understanding necessary for cost-effective intelligent processing of ceramic matrix composites.

30136 (ORNL/TM–12963, pp. 293-301) **Microwave joining of SiC.** Silberglitt, R. (FM Technologies, Inc., Fairfax, VA (United States)); Ahmad, I.; Black, W.M. Oak Ridge National Lab., TN (United States). May 1995. In *Advanced Industrial Materials (AIM) Program. Annual progress report, FY 1994.* 341p. Order Number DE95016129. Source: OSTI; NTIS; GPO Dep.

The purpose of this work is to optimize the properties of SiC-SiC joints made using microwave energy. The current focus is on optimization of time-temperature profiles, production of SiC from chemical precursors, and design of new applicators for joining of long tubes.

30137 (ORNL/TM–12963, pp. 303-314) **Microwave processing of ceramic oxide filaments.** Vogt, G.J. (Los Alamos National Laboratory, NM (United States)); Katz, J.D. Oak Ridge National Lab., TN (United States). May 1995. In *Advanced Industrial Materials (AIM) Program. Annual progress report, FY 1994.* 341p. Order Number DE95016129. Source: OSTI; NTIS; GPO Dep.

The objective of the microwave filament processing project is to develop microwave techniques at 2.45 GHZ to manufacture continuous ceramic oxide filaments. Microwave processing uses the volumetric absorption of microwave power in oxide filament tows to drive off process solvents, to burn out organic binders, and to sinter the dried fibers to produce flexible, high-strength ceramic filaments. The technical goal is to advance filament processing technology by microwave heating more rapidly with less energy and at a lower cost than conventional processing, but with the same quality as conventional processing. The manufacturing goal is to collaborate with the 3M Company, a US manufacturer of ceramic oxide filaments, to evaluate the technology using a prototype filament system and to transfer the microwave technology to the 3M Company.

30138 (ORNL/TM–12963, pp. 315-323) **Selective inorganic thin films.** Phillips, M.L.F. (Sandia National Laboratories, Albuquerque, NM (United States)); Weisenbach, L.A.; Anderson, M.T. Oak Ridge National Lab., TN (United States). May 1995. In *Advanced Industrial Materials (AIM) Program. Annual progress report, FY 1994.* 341p. Order Number DE95016129. Source: OSTI; NTIS; GPO Dep.

This project is developing inorganic thin films as membranes for gas separation applications, and as discriminating coatings for liquid-phase chemical sensors. Our goal is to synthesize these coatings with tailored porosity and surface chemistry on porous substrates and on acoustic and optical sensors. Molecular sieve films offer the possibility of performing separations involving hydrogen, air, and natural gas constituents at elevated temperatures with very high separation factors. We are focusing on improving permeability and molecular sieve properties of crystalline zeolitic membranes made by hydrothermally reacting layered multicomponent sol-gel films deposited on mesoporous substrates. We also used acoustic plate mode (APM) oscillator and surface plasmon resonance (SPR) sensor elements as substrates for sol-gel films, and have both used these modified sensors to determine physical properties of the films and have determined the sensitivity and selectivity of these sensors to aqueous chemical species.

30139 (SAND–95-0782C) **Experimental measurements of shock properties of stishovite.** Furnish, M.D. (Sandia National Labs., Albuquerque, NM (United States)); Ito, E. Sandia National Labs., Albuquerque, NM (United States). [1995]. 5p. Sponsored by USDOE, Washington, DC (United States);Defense Nuclear Agency, Washington, DC (United States). DOE Contract AC04-94AL85000. (CONF-950846–47: American Physical Society biennial conference on shock compression of condensed matter, Seattle, WA (United States), 13-18 Aug 1995). Order Number DE96000778. Source: OSTI; NTIS; GPO Dep.

We have synthesized, characterized and performed Hugoniot measurements on monolithic samples of stishovite, a high pressure polymorph of silica. Synthesis was accomplished in a multianvil press with pyrophyllite gaskets and carbon heaters. The samples had densities ranging from 3.80 to 4.07, corresponding to stishovite volume fractions of 0.7 to 0.87, a range confirmed by NMR analysis. They had no significant impurities except less than 1% carbon. Samples ~ 1 mm thick and 3 mm diameter were tested in reverse- and forward-ballistics modes on a two-stage light gas gun, using velocity interferometry diagnostics. Impact velocities ranged from 4.0 to 6.5 km/sec. Hugoniot stresses for the four successful tests ranged from 65 to 225GPa. At higher stresses significant uncertainties arise due to impact tilt/nonplanariy issues. Results are consistent with earlier predictions of the stishovite Hugoniot based on quartz-centered Hugoniot data, static-compression (diamond-anvil cell) data and hydrostatic multianvil cell data. Release behavior appears to be frozen. These results are remarkable in view of the small size of the samples used.

30140 (SAND–95-0838C) **Shock-wave properties of brittle solids.** Grady, D.E. Sandia National Labs., Albuquerque, NM (United States). [1995]. 13p. Sponsored by USDOE, Washington, DC (United States). DOE Contract AC04-94AL85000. (CONF-950846–46: American Physical Society biennial conference on shock compression of condensed matter, Seattle, WA (United States), 13-18 Aug 1995). Order Number DE96000787. Source: OSTI; NTIS; GPO Dep.

Extensive experimental investigation in the form of large-amplitude, nonlinear wave-profile measurements which manifest the shock strength and equation-of-state properties of brittle solids has been performed. Brittle materials for which a base of dynamic property data is available include Al_2O_3, AlN, B_4C, $CaCO_3$, SiC, Si_3N_4, SiO_2 (quartz and glass), TiB_2, WC and ZrO_2. Planar impact methods and velocity interferometry diagnostics have been used exclusively to provide the high-resolution shock-profile data. These wave-profile data are providing engineering dynamic strength and equation-of-state properties as well as controlled, shock-induced motion histories for the validation of theoretical and Computational models. Of equal importance, such data are providing a window into the physics of a newly emerging understanding of the compression and deformation behavior of high-strength brittle solids. When considered along with a rich assortment of strength and deformation data in the literature, a systematic assessment of this shock-wave data lends strong support for failure waves and concomitant high-confinement dilatancy as a general mechanism of inelastic deformation in the shock compression of ceramics. Phase transformation in selected brittle solids appears to be a critical state phenomenon strongly controlled by kinetics. The risetime and structure of deformation shock waves in brittle solids are controlled by viscous effects which at present are still poorly understood. The shockwave data also suggest that both crystalline plasticity and brittle fracture may play important and interconnected roles in the dynamic failure process.

30141 (SAND–95-0949C) **Status of ion implantation doping and isolation of III-V nitrides.** Zolper, J.C. (Sandia National Labs., Albuquerque, NM (United States)); Pearton, S.J.; Abernathy, C.R. Sandia National Labs., Albuquerque, NM (United States). 1995. 8p. Sponsored by USDOE, Washington, DC (United States);National Science Foundation, Washington, DC (United States). DOE Contract AC04-94AL85000. (CONF-951007–5: 188. meeting of the Electrochemical Society, Chicago, IL (United States), 8-13 Oct 1995). Order Number DE95017888. Source: OSTI; NTIS; GPO Dep.

Ion implantation doping and isolation has played a critical role in the realization of high performance photonic and electronic devices in all mature semiconductor material systems. This is also expected to be the case for the binary III-V nitrides (InN, GaN, and AlN) and their alloys as the epitaxial material quality improves and more advanced device structures are fabricated. With this in mind, we review the status of implant doping and isolation of GaN and the ternary alloys AlGaN, InGaN, and InAlN. In particular, we reported on the successful n- and p-type doping of GaN by ion implantation of Mg+P and Si, respectively, and subsequent high temperature rapid thermal anneals in excess of 1000°C. In the area of implant isolation, N-implantation has been shown to compensate both n- and p-type GaN, N and O-implantation effectively compensates InAlN, and InGaN shows limited compensation with either N or F implantation.

30142 (SAND–95-1751C) **Applied mechanics modeling of granulated ceramic powder compaction.** Mahoney, F.M.; Readey, M.J. Sandia National Labs., Albuquerque, NM (United States). [1995]. 15p. Sponsored by USDOE, Washington, DC (United States). DOE Contract AC04-94AL85000. (CONF-9509214–1: 27. international Society for the Advancement of Materials and Process Engineering (SAMPE) technical conference, Albuquerque, NM (United States), 10-12 Sep 1995). Order Number DE95016405. Source: OSTI; NTIS; GPO Dep.

In ceramic manufacturing processes such as dry-pressing, correlations between applied compacting pressure and resultant powder compact density are essential for defining reliable process conditions for ceramic components. Pressure-density diagrams have been developed as a tool for both process control and for understanding the compaction behavior of different powders. These types of diagrams, however, pertain only to the averag@ properties of a powder compact and do not address a significant issue in powder compaction processes: the formation of density gradients within the compact. Continuum-based mechanics models of varying complexity have addressed the influence of frictional forces acting at the powder-die wall interface which dissipate the applied pressure throughout the compact. Resulting pressure distribution models are then typically coupled with empirical functions relating pressure and density to obtain a green density distribution in the compact. All of these models predict similar trends; however, none predict the distribution with sufficient accuracy to be considered as a design tool for industrial applications.

30143 (SAND–95-1969C) **Shock-induced changes in HgO powder.** Venturini, E.L.; Newcomer, P.P.; Morosin, B.; Holman, G.T.; Dunn, R.G.; Graham, R.A. Sandia National Labs., Albuquerque, NM (United States). [1995]. 8p. Sponsored by USDOE, Washington, DC (United States). DOE Contract AC04-94AL85000. (CONF-950856–5: 4. international conference on metallurgical and materials applications of shock-wave and high-strain-rate phenomena, El Paso, TX (United States), 6-10 Aug 1995). Order Number DE96000763. Source: OSTI; NTIS; INIS; GPO Dep.

Powder compacts of HgO were subjected to explosively-generated shock-wave loading in Sandia Bear fixtures and recovered for analysis. Although XRD powder spectra show only the orthorhombic form of HgO in both the as-received and recovered samples, XRD line profiles and TEM indicate up to an order of magnitude increase in crystallite size. Magnetic data reveal a superconducting transition below 4.2 K that is attributed to metallic α-Hg formed by a partial, shock-induced decomposition of the HgO, consistent with TEM identification of α-Hg particles using a cold stage. In addition, paramagnetic impurities present in the as-received HgO powder appear to be partially converted to a ferromagnetic or ferrimagnetic phase that dominates the magnetic properties of the recovered powder. The amounts of both the superconducting and ferromagnetic phases vary strongly with position within the shock recovery capsules.

30144 (SAND–95-2101C) **ECR etching of group-III nitride binary and ternary films.** Shul, R.J. (Sandia National Labs., Albuquerque, NM (United States)); Howard, A.J.; Pearton, S.J. Sandia National Labs., Albuquerque, NM (United States). [1995]. 14p. Sponsored by USDOE, Washington, DC (United States). DOE Contract AC04-94AL85000. (CONF-951007–4: 188. meeting of the Electrochemical Society, Chicago, IL (United States), 8-13 Oct 1995). Order Number DE96000782. Source: OSTI; NTIS; GPO Dep.

Due to their wide band gaps and high dielectric constants, the group III-nitrides have made significant impact on the compound semiconductor community as blue and ultraviolet light emitting diodes (LEDs) and for their potential use in laser structures and high temperature electronics. Processing of these materials, in particular wet and dry etching, has proven to be extremely difficult due to their inert chemical nature. We report electron cyclotron resonance (ECR) etch rates for GaN, InN, AlN, $In_{(x)}Ga_{(1-x)}Ni$ and $In_{(x)}Al_{(1-x)}N$ as a function of temperature, rf-power, pressure, and microwave power. Etch conditions are characterized for rate, profile, and sidewall and surface morphology. Atomic force microscopy (AFM) is used to quantify RMS roughness of the etched surfaces. We observe consistent trends for the InAlN films where the etch rates increase with increasing concentration of In. The trends are far less consistent for the InGaN with a general decrease in etch rate as the In concentration is increased.

30145 (SAND–95-2102C) **Hydrogen incorporation into III-V nitrides during processing.** Pearton, S.J. (Univ. of Florida, Gainesville, FL (United States)); Abernathy, C.R.; Vartuli, C.B. Sandia National Labs., Albuquerque, NM (United States). [1995]. 20p. Sponsored by USDOE, Washington, DC (United States);National Science Foundation, Washington, DC (United States);Department of Defense, Washington, DC (United States). DOE Contract AC04-94AL85000. (CONF-951007–3: 188. meeting of the Electrochemical Society, Chicago, IL (United States), 8-13 Oct 1995). Order Number DE96000783. Source: OSTI; NTIS; GPO Dep.

Hydrogen is readily incorporated into GaN and related alloys during wet and dry etching, chemical vapor deposition of dielectric overlayers, boiling in water and other process steps, in addition to its effects during MOCVD or MOMBE growth. The hydrogen is bound at defects or impurities and passivates their electrical activity. Reactivation occurs at 450-550°C, but evolution from the crystal requires much higher temperatures ($\geq$ 800°C).

30146 (SAND–95-2108C) **Photo- and cathodoluminescence of hydrothermally synthesized $Y_3Al_5O_{12}$:Tb and $NaY(WO_4)_2$:Tb.** Phillips, M.L.F.; Potter, B.G. Jr. Sandia National Labs., Albuquerque, NM (United States). [1995]. 20p. Sponsored by USDOE, Washington, DC (United States). DOE Contract AC04-94AL85000. (CONF-9404286–1: Synthesis and application of lanthanide-doped ceramics, Cincinnati, OH (United States), 30 Apr - 4 may 1994). Order Number DE96000707. Source: OSTI; NTIS; GPO Dep.

Cathodoluminescent (CL) phosphors with improved low-voltage characteristics are needed for use in emissive flat panel displays. Conventional high-temperature methods for phosphor synthesis yield large polycrystalline grains that must be pulverized prior to screen deposition. Grinding has been implicated in reducing phosphor efficiency by causing surface contamination and defects. Hydrothermal synthesis has been used to improve the quality of ceramic powders by producing fine, well-formed crystallites without grinding. Two green-emitting phosphors, $Y_3Al_5O_{12}$:Tb (YAG:Tb) and $NaY(WO_4)_2$:Tb, were used to test the effects of hydrothermal. synthesis on grain size and morphology, and on low-voltage CL properties. YAG:Th prepared hydrothermally consisted of submicron crystallites with a typical garnet habit. The CL efficiency of hydrothermally synthesized YAG:Tb (3 lm/W at 800 V) was comparable to that of equivalent YAG:Tb compositions prepared via high-temperature solid state reaction. In comparison, CL intensities of $Gd_3Ga_5O_{12}$:Tb were slightly better (3.5 lm/W at 800 V), while those of $NaY(WO_4)_2$:Tb were approximately 1/100th that of YAG:Tb. Both CL and photoluminescence data show that the difference in the cathodoluminescence of YAG and $NaY(WO_4)_2$ can be understood in terms of differences in the mechanism of activation.

30147 (SAND–95-2180C) **Novel compound semiconductor devices based on III-V nitrides.** Pearton, S.J. (Florida Univ., Gainesville, FL (United States)); Abernathy, C.R.; Ren, F. Sandia National Labs., Albuquerque, NM (United States). [1995]. 10p. Sponsored by USDOE, Washington, DC (United States). DOE Contract AC04-94AL85000. (CONF-951243–1: 1. IEEE international Caracas conference on devices circuits and systems, Caracas (Venezuela), 12-14 Dec 1995). Order Number DE96000708. Source: OSTI; NTIS; GPO Dep.

New developments in dry and wet etching, ohmic contacts and epitaxial growth of III-V nitrides are reported. These make possible devices such as microdisk laser structures and GaAs/AlGaAs heterojunction bipolar transistors with improved InN ohmic contacts.

30148 (SAND–95-2192C) **The effect of grain shape on strength variability of alumina ceramics.** Readey, M.J. Sandia National Labs., Albuquerque, NM (United States). [1995]. 20p. Sponsored by USDOE, Washington, DC (United States);Department of Defense, Washington, DC (United States). DOE Contract AC04-94AL85000. Grant F4962092-J0034. (CONF-950713–1: 6. international symposium on fracture mechanics of ceramics, Karlsruhe (Germany), 18-20 Jul 1995). Order Number DE96000698. Source: OSTI; NTIS; GPO Dep.

Fine-grained and coarse-grained aluminas containing either equiaxed or elongated grain structures were fabricated from commercial-purity and high-purity alumina powders. Compared to the high-purity aluminas, the commercial-purity aluminas having a coarse grain size and elongated grain structures exhibited significantly more pronounced flaw tolerance and T-curve behavior. T-curve behavior determined from indentation strength tests suggested that only the coarse- grained, elongated-grain alumina had a T-curve sufficient to cause stable crack extension prior to failure, a requirement for any observable improvement in reliability. In the high-purity aluminas as well as the fine-grained commercial-purity aluminas, however, it is likely that little or no stable extension occurs prior failure, suggesting that strength in these materials is dependent on the critical flaw size. Strength tests on polished specimens showed the commercial-purity aluminas had a lower means strength than the high- purity aluminas and the coarse-grained aluminas exhibited a lower mean strength compared to the fine-grained aluminas. An analysis of the mean strength versus grain size revealed that the differences in critical flaw size alone could not account for the differences in mean strength. Instead, a combination of changes in flaw size as well as T-curve behavior were shown to be responsible for the differences in strength and flaw tolerance. T-curve behavior was also found to have a profound influence on the strength variability of alumina. For example, the Weibull modulus for the coarse-grained, commercial- purity alumina was almost twice that of the fine-grained, high-purity material. Tests with indented specimens conclusively demonstrated that improvements in reliability in these materials are not due solely to changes in the critical flaw size distribution but rather a combination of flaw size distribution and T-curve behavior.

30149 (SAND–95-2254C) **Rietveld refinement of $YBa_2Cu_{3-x}Ni_xO_y$ prepared by quenching and oxygen gettering.** Rodriguez, M. (Sandia National Labs., Albuquerque, NM (United States)); Eatough, M.; Licci, F. Sandia National Labs., Albuquerque, NM (United States). [1995]. 7p. Sponsored by USDOE, Washington, DC (United States). DOE Contract AC04-94AL85000. (CONF-9507175–1: 44. annual Denver x-ray conference, Colorado Springs, CO (United States), 31 Jul - 4 aug 1995). Order Number DE96000788. Source: OSTI; NTIS; GPO Dep.

We have refined the structures for $YBa_2Cu_{2.94}Ni_{0.06}O_y$ (2% Ni) and $YBa_2Cu_{2.80}Ni_{0.20}O_y$ (6.67% Ni) at $y \sim 6.95$ and $y \sim 6.5$ contents. Oxygen was reduced by two independent methods: quenching from 690°C and oxygen gettering at 450°C. Cu-0 bond lengths were calculated based on Rietveld structure refinements for the various samples; they indicate the likely occupancy of Ni in the plane (Cu2) site of the 123 superconductor.

30150 (UM-P–94/28) **Effect of ion implantation on thermal shock resistance of magnesia and glass.** Gurarie, V.N. (Melbourne Univ., Parkville, VIC (Australia). School of Physics); Williams, J.S.; Watt, A.J. Melbourne Univ., Parkville, VIC (Australia). School of Physics. [1995]. 17p. Order Number DE96602566. Source: OSTI; NTIS; INIS.

Monocrystals of magnesia together with glass samples have been subjected to ion implantation prior to thermal shock testing in an impulse plasma of continuously varied intensity. Measurements of the separation between fragments have been used to estimate the surface temperature. Fracture and deformation characteristics of the surface layer are measured in ion implanted and unimplanted samples using optical and scanning electron microscopy. Implantation-induced near-surface damage is analysed by ion channeling using 2 MeV He^+ ions. Ion implantation is shown to modify the near-surface structure of magnesia samples by introducing damage, which makes crack initiation easier under thermal stresses. The fracture threshold and maximum crack density are shifted towards the lower temperature range. Ion implanted MgO crystals show a ten fold increase in surface crack density. An increased crack density results in a decreased degree of damage characterised by the depth of crack penetration. The thermal stress resistance parameter of glass samples is increased at relatively small doses and decreased at higher doses. The results suggest that crack density and the degree of fracture damage in brittle ceramics operating under thermal shock conditions can be effectively controlled by ion implantation which provides crack initiating defects in the near-surface region. 23 refs., 7 figs.

30151 (UM-P–94/130) **Crystalline and amorphous carbon nitride films produced by high-energy shock plasma deposition.** Bursilll, L.A.; Peng, Julin; Gurarie, V.N.; Orlov, A.V.; Prawer, S. Melbourne Univ., Parkville, VIC (Australia). School of Physics. [1995]. 22p. Sponsored by Australian Research Council, Canberra, ACT (Australia). Order Number DE96602557. Source: OSTI; NTIS; INIS.

High-energy shock plasma deposition techniques are used to produce carbon-nitride films containing both crystalline and amorphous components. The structures are examined by high-resolution transmission electron microscopy, parallel-electron-energy loss spectroscopy and electron diffraction. The crystalline phase appears to be face-centered cubic with unit cell parameter approx. a=0.63nm and it may be stabilized by calcium and oxygen at about

1-2 at % levels. The carbon atoms appear to have both trigonal and tetrahedral bonding for the crystalline phase. There is PEELS evidence that a significant fraction of the nitrogen atoms have sp^2 trigonal bonds in the crystalline phase. The amorphous carbon-nitride film component varies from essentially graphite, containing virtually no nitrogen, to amorphous carbon-nitride containing up to 10 at % N, where the fraction of sp^3 bonds is significant. 15 refs., 5 figs.

30152 (UM-P–95/15) **HRTEM analysis of nanodomain textures in PMN.** Fan, Xudong; Qian, Hua; Peng Julin; Bursill, L.A. Melbourne Univ., Parkville, VIC (Australia). School of Physics. 1995. 10p. Sponsored by Australian Research Council, Canberra, ACT (Australia). Order Number DE96602559. Source: OSTI; NTIS; INIS.

Chemical domain textures of PMN are modelled using next-nearest-neighbour Ising (NNNI) models and Monte Carlo methods. These simulations allow us to understand and quantify the local structures of clusters of Nb and Mg atoms and how these interact to form chemical domain walls and other configuration including charged chemical defects. This model for the B-site distribution is used for image simulations. Both HRTEM many-beam bright-and dark single-beam TEM images are obtained and compared with the experimental images. The final result is a realistic atomic model for the Nb, Mg distribution of PMN. 10 refs., 6 figs.

3606 Other Materials

Refer also to citation(s) 28801, 28918, 28943, 28972, 29011, 29388, 29468, 29489, 29798, 29814, 29916, 29926, 29947, 30028, 30040, 30055, 30083, 30084, 30126, 30197, 30238, 30257, 30350, 30368, 30377, 30378, 30381, 30389, 30392, 30394, 30517, 30520, 30548, 31102, 31131, 31132, 31135, 31138, 31149, 31260

30153 (ANL/CMT/CP–84718) **Evaluation of models of waste glass durability.** Ellison, A. Argonne National Lab., IL (United States). [1995]. 15p. Sponsored by USDOE, Washington, DC (United States). DOE Contract W-31-109-ENG-38. (CONF-950402–15: 209. American Chemical Society (ACS) national meeting, Anaheim, CA (United States), 2-6 Apr 1995). Order Number DE95015833. Source: OSTI; NTIS; INIS; GPO Dep.

The main variable under the control of the waste glass producer is the composition of the glass; thus a need exists to establish functional relationships between the composition of a waste glass and measures of processability, product consistency, and durability. Many years of research show that the structure and properties of a glass depend on its composition, so it seems reasonable to assume that there also is relationship between the composition of a waste glass and its resistance to attack by an aqueous solution. Several models have been developed to describe this dependence, and an evaluation their predictive capabilities is the subject of this paper. The objective is to determine whether any of these models describe the "correct" functional relationship between composition and corrosion rate. A more thorough treatment of the relationships between glass composition and durability has been presented elsewhere, and the reader is encouraged to consult it for a more detailed discussion. The models examined in this study are the free energy of hydration model, developed at the Savannah River Laboratory, the structural bond strength model, developed at the Vitreous State Laboratory at the Catholic University of America, and the Composition Variation Study, developed at Pacific Northwest Laboratory.

30154 (BNL–61479) **Diamond-like atomic-scale composite films: Surface properties and stability studied by STM and AFM.** Dorfman, B. (SUNY, Farmingdale, NY (United States)); Abraizov, M.; Pollak, F.H.; Eby, R.; Rong, Z.Y.; Strongin, M.; Yang, X.Q. Brookhaven National Lab., Upton, NY (United States). [1995]. 4p. Sponsored by USDOE, Washington, DC (United States). DOE Contract AC02-76CH00016. (CONF-950840–4: International conference on applications of diamond films and related materials, Gaithersburg, MD (United States), 21-24 Aug 1995). Order Number DE96000431. Source: OSTI; NTIS; GPO Dep.

Amorphous "diamond-like/quartz-like" composites a-(C:H/Si:O) and metal containing a-(C:H/Si:O/Me) constitute a novel class of diamond-related materials with a number of unique bulk and surface properties. In order to gain a more fundamental understanding of the surface properties and stability of these solids we have performed a scanning tunneling and atomic force microscopy investigation of both a-(C:H/Si:O) and a-(C:H/Si:O/Me) films, including the effects of ion bombardment and annealing.

30155 (CONF-9505204–11) **A novel carbon fiber based porous carbon monolith.** Burchell, T.D.; Klett, J.W.; Weaver, C.E. Oak Ridge National Lab., TN (United States). 1995. 10p. Sponsored by USDOE, Washington, DC (United States). DOE Contract AC05-84OR21400. From 9. annual conference on fossil energy materials: Oak Ridge, TN (United States): 16-18 May 1995. Order Number DE95014252. Source: OSTI; NTIS; GPO Dep.

A novel porous carbon material based on carbon fibers has been developed. The material, when activated, develops a significant micro- or mesopore volume dependent upon the carbon fiber type utilized (isotropic pitch or polyacrylonitrile). The materials will find applications in the field of fluid separations or as a catalyst support. Here, the manufacture and characterization of our porous carbon monoliths are described.

30156 (DOE/ER–0313/17, pp. 274-288) **Advanced SiC composites for fusion applications.** Snead, L.L. (Oak Ridge National Lab., TN (United States)); Schwarz, O.J. Oak Ridge National Lab., TN (United States). Apr 1995. DOE Contract AC05-84OR21400. In *Fusion materials semiannual progress report for the period ending September 30, 1994.* 390p. Order Number DE95013663. Source: OSTI; NTIS; INIS; GPO Dep.

This is a short review of the motivation for and progress in the development of ceramic matrix composites for fusion. Chemically vapor infiltrated silicon carbide (SiC) composites have been fabricated from continuous fibers of either SiC or graphite and tested for strength and thermal conductivity. Of significance is the the Hi-Nicalon™ SiC based fiber composite has superior unirradiated properties as compared to the standard Nicalon grade. Based on previous results on the stability of the Hi-Nicalon fiber, this system should prove more resistant to neutron irradiation. A graphite fiber composite has been fabricated with very good mechnical properties and thermal conductivity an order of magnitude higher than typical SiC/SiC composites.

30157 (DOE/ER–0313/17, pp. 289-295) **Thermal conductivity degradation of graphites irradiated at low temperature.** Snead, L.L. (Oak Ridge National Lab., TN (United States)); Burchell, T.D. Oak Ridge National Lab., TN (United States). Apr 1995. DOE Contract AC05-84OR21400. In *Fusion materials semiannual progress report for the period ending September 30, 1994.* 390p. Order Number DE95013663. Source: OSTI; NTIS; INIS; GPO Dep.

The objective of this work is to study the thermal conductivity degradation of new, high thermal conductivity graphites and to compare these results to more standard graphites irradiated at low temperatures. Several graphites and graphite composites (C/C's) have been irradiated near 150°C and at fluences up to a displacement level of 0.24 dpa. The materials ranged in unirradiated room temperature thermal conductivity of these materials varied from 114 W/m-K for H-451 isotropic graphite, to 670 W/m-K for unidirectional FMI-1D C/C composite. At the irradiation temperature a saturation reduction in thermal conductivity was seen to occur at displacement levels of approximately 0.1 dpa. All materials were seen to degrade to approximately 10 to 14 % of their original thermal conductivity after irradiation. The effect of post irradiation annealing on the thermal conductivity was also studied.

30158 (DOE/ER–0313/17, pp. 296-310) **Incubation time for sub-critical crack propagation in SiC-SiC composites.** El-Azab, A. (Univ. of California, Los Angeles, CA (United States)); Ghoniem, N.M. Oak Ridge National Lab., TN (United States). Apr 1995. DOE Contract FG03-91ER54115. In *Fusion materials semiannual progress report for the period ending September 30, 1994.* 390p. Order Number DE95013663. Source: OSTI; NTIS; INIS; GPO Dep.

The objective of this work is to investigate the time for sub-critical crack propagation is SiC-SiC composites at high temperatures. The effects of fiber thermal creep on the relaxation of crack bridging tractions in SiC-SiC ceramic matrix composites (CMCs) is considered in the present work, with the objective of

studying the time-to propagation of sub-critical matrix cracks in this material at high temperatures. Under the condition of fiber stress relaxation in the bridiging zone, it is found that the crack opening and the stress intensity factor increase with time for sub-critical matrix cracks. The time elapsed before the stress intensity reaches the critical value for crack propagation is calculated as a function of the initial crack length, applied stress and temperature. Stability domains for matrix cracks are defined, which provide guidelines for conducting high-temperature crack propagation experiments.

30159 (DOE/ER–0313/17, pp. 311-320) **Apparent activation energy of subcritical crack growth of SiC/SiC composites at elevated temperatures.** Chou, Y.S. (Univ. of Washington, Seattle, WA (United States)); Stackpoole, M.M.; Bordia, R. Oak Ridge National Lab., TN (United States). Apr 1995. DOE Contract AC06-76RL01830. In *Fusion materials semiannual progress report for the period ending September 30, 1994.* 390p. Order Number DE95013663. Source: OSTI; NTIS; INIS; GPO Dep.

The purpose of this study is to investigate the environmental effect of oxygen-containing gases on the subcritical crack growth of continuous fiber (Nicalon "SiC") reinforced ceramic matrix (SiC) composites at elevated temperatures. This is a continuing project and the primary goal for this time period is to obtain an apparent activation energy for SiC/SiC materials with two different interfaces: carbon and boron nitride coatings. In the past six months, the authors have conducted studies of subcritical crack growth on SiC/SiC composite materials in a corrosive (O_2) as well as an inert (Ar) atmosphere for temperatures ranging from 800 to 1100°C.

30160 (DOE/ER–0313/17, pp. 321-330) **Effects of neutron irradiation on dimensional stability and on mechanical properties of SiC/SiC composites.** Youngblood, G.E. (Pacific Northwest Lab., Richland, WA (United States)); Henager, C.H. Jr.; Senor, J. Oak Ridge National Lab., TN (United States). Apr 1995. DOE Contract AC06-76RL01830. In *Fusion materials semiannual progress report for the period ending September 30, 1994.* 390p. Order Number DE95013663. Source: OSTI; NTIS; INIS; GPO Dep.

The objective of this work is to assess the development and the performance of continuous fiber SiC_f/SiC composites as a structural material for advanced fusion reactor application. The dimensional stability and some mechanical properties of two similar 2D 0-90° weave SiC_f/SiC composites made with Nacalon™ ceramic-grade fiber were characterized and compared after neutron irradiation to those properties for β-SiC. The major difference between these two composites was that one had a thin (150 nm) and the other a thick (1000 nm) graphite interface layer. The irradiation conditions consisted of relatively high doses (4.3 to 26 dpa-SiC) at high temperature (430-1200°C).

30161 (DOE/ER–0313/17, pp. 379-384) **Optical absorption and luminescence in neutron-irradiated, silica-based fibers.** Cooke, D.W. (Los Alamos National Lab., CA (United States)); Farnum, E.H.; Clinard, F.W. Oak Ridge National Lab., TN (United States). Apr 1995. In *Fusion materials semiannual progress report for the period ending September 30, 1994.* 390p. Order Number DE95013663. Source: OSTI; NTIS; INIS; GPO Dep.

The objectives of this work are to assess the effects of thermal annealing and photobleaching on the optical absorption of neutron-irradiated, silica fibers of the type proposed for use in ITER diagnostics, and to measure x-ray induced luminescence of unirradiated (virgin) and neutron-irradiated fibers.

30162 (DOE/ER/45522–3) **Asymmetrical polarization of spherical colloidal particle double layer in electrical fields.** Hu, Y. (Wellesley College, MA (United States). Physics Dept.); Kumar, V.; Fraden, S. Brandeis Univ., Waltham, MA (United States). Apr 1995. 9p. Sponsored by USDOE, Washington, DC (United States);National Science Foundation, Washington, DC (United States);Henry Luce Foundation, New York, NY (United States). DOE Contract FG02-94ER45522. (CONF-940813–42: 208. American Chemical Society national meeting, Washington, DC (United States), 21-26 Aug 1994). Order Number DE96000734. Source: OSTI; NTIS; GPO Dep.

It has long been accepted that the drastic increase in the viscosity of electrorheological fluids subjected to electric fields is due to interactions between the induced dipole moments of the colloidal particles in the suspensions. Computer simulations of dipole-dipole interactions have produced chain and column formations of particles in the direction of the applied field that agree well with experimental observations. In an aqueous suspension of colloidal particles, however, the polarization of particles is very sensitive to the frequency of the applied electric field, and the dynamics of the particles can differ drastically from the dynamics that would be expected from a simple induced dipole model. In certain frequency regimes, instead of forming chains and columns in the direction of a linear applied field, the particles are dynamically unstable and circulate in bands that tilt at a significant angle relative to the direction of the field. This indicates that the interactions between the particles are no longer symmetrical with respect to the applied electric field. The authors have proposed a phenomenological model to explain the mechanism of this symmetry breaking. They have carried out a computer simulation of colloidal particle dynamics resulting from their model, and the results of the simulation agree well with experimental observations. When a particle is spinning, the diffusion of the ions in the double layer becomes asymmetrical with respect to the electric field, with the ions diffusing faster in the direction of spinning than against it. This causes the induced dipole moment of the particle to be misaligned with respect to the applied field. The authors earlier simulation results show that this misalignment between the polarization of the particle and the applied electric field plays a crucial role in the formation of a band of particles tilted at an angle relative to the direction of the applied electric field.

30163 (DOE/OR/21400–T489) **Formation of novel optical materials by ion implantation.** Oak Ridge National Lab., TN (United States). [1995]. 4p. Sponsored by USDOE, Washington, DC (United States). DOE Contract AC05-84OR21400. Order Number DE96000670. Source: OSTI; NTIS; GPO Dep.

Ion implantation into glasses shows considerable promise as a technique for producing novel materials having unique optical properties. There is also significant commercial interest in the marketing of optical waveguides, high-performance polarizing glasses, and birefringent glasses. In this work, special glass compositions, including both two-phase and anisotropic materials, were prepared by bulk processing techniques and then implanted with Ag, Au, and Cu ions at different temperatures, energies, and doses. The composite materials produced showed strong resonant absorption at the surface plasmon resonance frequency. The plasmon frequency was consistent with the formation of spherical colloids of the implanted metals having diameters on the order of 10 nm. No anisotropic behavior of the implanted materials was observed. Possible applications for these materials, had such anisotropy been developed, would have included optical isolators, Faraday rotators, optical waveguides, and switching devices for use in optical communication and computing.

30164 (DOE/OR/21400–T497) **[A variable frequency microwave furnace]. CRADA final report for CRADA Number ORNL91-0055.** Lauf, R.J. Oak Ridge National Lab., TN (United States). 8 Dec 1994. 4p. Sponsored by USDOE, Washington, DC (United States). DOE Contract AC05-84OR21400. Order Number DE96000678. Source: OSTI; NTIS; GPO Dep.

The goals of this CRADA were to: (1) development and demonstrate a highly frequency-agile microwave furnace; (2) explore applications of the furnace for materials processing; and (3) develop control systems and packaging that are robust, user-friendly, and suitable for sale as a turnkey system. Microwave Laboratories, Inc. (MLI) designed, built, and successfully brought to market a benchtop Variable Frequency Microwave Furnace (VFMF). The concept has demonstrated advantages in polymer curing, waste remediation, and diamond (CVD). Through experimentation and modeling, the VFMF approach has gained credibility within the technical community.

30165 (IS-M–825) **Spectroscopic ellipsometry and band structure of $Si_{1-y}C_y$ alloys grown pseudomorphically on Si (001).** Zollner, S. (Ames Lab., IA (United States)); Herzinger, C.M.; Woollam, J.A.; Iyer, S.S.; Powell, A.P.; Eberl, K. Ames Lab., IA (United States). [1995]. 6p. Sponsored by USDOE, Washington, DC (United States). DOE Contract W-7405-ENG-82. (CONF-950412–54: Spring meeting of the Materials Research Society

(MRS), San Francisco, CA (United States), 17-21 Apr 1995). Order Number DE96000212. Source: OSTI; NTIS; GPO Dep.

The authors have measured the dielectric functions of three $Si_{1-y}C_y$ alloys layers ($y \leq 1.4\%$) grown pseudomorphically on Si (001) substrates using molecular beam epitaxy at low temperatures. From the numerical derivatives of the measured spectra, they determine the critical point energies E_0' and E_1 as a function of y ($y \leq 1.4\%$) using a comparison with analytical line shapes and analyze these energies in terms of the expected shifts and splittings due to negative hydrostatic pressure, shear stress, and alloying. Their data agree well with the calculated shifts for E_1, but the E_0' energies are lower than expected. They discuss their results in comparison with recent tight-binding molecular dynamics simulations by Demkov and Sankey predicting a total breakdown of the virtual-crystal approximation for such alloys.

30166 (IS-T–1738) **Synthesis and study of novel silicon-based unsaturated polymers.** Lin, J. Ames Lab., IA (United States). 19 Jun 1995. 224p. Sponsored by USDOE, Washington, DC (United States);National Science Foundation, Washington, DC (United States);Iowa State Univ. of Science and Technology, Ames, IA (United States). DOE Contract W-7405-ENG-82. Order Number DE96000220. Source: OSTI; NTIS; GPO Dep.

Novel unsaturated polymers have been synthesized and studied as precursors to silicon carbide and third order nonlinear optical materials. X ray structures were obtained. Kinetic and mechanistic studies of the unique thermal isomerization of dimethylenedisilacyclobutane to a carbene were conducted.

30167 (KRC–92C-S05) **Investigation on the damage of the electric facilities by air pollutants.** Lee, T.W. (Korea Electric Power Corp. (KEPCO), Taejon (Korea, Republic of). Research Center); Han, S.W.; Lee, S.J. Korea Electric Power Corp. (KEPCO), Taejon (Korea, Republic of). Research Center. 1993. 132p. (In Korean). Order Number DE96703576. Source: OSTI; NTIS (US Sales Only).

Although the air pollution level through the nation is becoming lower, it is true that in some metropolitan and industrial area air pollution level stays somewhat high. The electric facilities are susceptible to be damaged by air pollutants because it is mainly made of metal and installed overhead. The survey conducted on the damage of electric facilities by air pollutants to understand present status and to suggest the necessity of further study revealed that the damage on some facilities in polluted area was diverse and serious. Therefore, it was considered that possible countermeasures should be taken. (author). 41 refs., figs.

30168 (LA-UR–95-2729) **Optical limiting and excited-state absorption in fullerene solutions and doped glasses.** McBranch, D. (and others); Smilowitz, L.; Klimov, V. Los Alamos National Lab., NM (United States). [1995]. 9p. Sponsored by USDOE, Washington, DC (United States). DOE Contract W-7405-ENG-36. (CONF-950793–27: 40. annual meeting of the Society of Photo-Optical Instrumentation Engineers, San Diego, CA (United States), 9-14 Jul 1995). Order Number DE95016963. Source: OSTI; NTIS; GPO Dep.

We report the ground state and excited state optical absorption spectra in the visible and near infrared for several substituted fullerenes and higher fullerenes in toluene solutions. Based on these measurements, broadband predictions of the optical limiting performance of these molecules can be deduced. These predictions are then tested at 532 to 700 nm in intensity-dependent transmission measurements. We observe optical limiting in all fullerenes measured; higher fullerenes show the greatest potential for limiting in the near infrared (650-1000 nm), while substituted C_{60} shows optimal limiting in the visible (450-700 nm). We observe dramatically reduced limiting for solid forms of C_{60} (thin films and C_{60}-doped porous glasses), indicating that efficient optical limiting in fullerenes requires true molecular solutions.

30169 (LA-UR–95-17922, pp. 504-510) **Radiation-induced segregation in materials: Implications for accelerator-driven neutron source applications.** Faulkner, R.B. (Loughborough Univ. of Technology (United Kingdom)); Song, S. Los Alamos National Lab., NM (United States). [1995]. (CONF-9407103–: International conference on accelerator-driven transmutation technologies and applications, Las Vegas, NV (United States), 25 Jul - 1 aug 1994). In *AIP conference on accelerator driven transmutation technologies and applications, Los Vegas, Nevada, July 25-29, 1994*. 958p. Order Number DE95014018. Source: OSTI; NTIS; INIS.

This paper reviews exisiting models for radiation-induced segregation to microstrucural interfaces and surfaces. It indicates how the models have been successfully used in the past in neutron irradiation situations and how they may be modified to account for accelerator-driven RIS. The predictions of the models suggest that any impurity with large misfit will suffer RIS and that the effect is heightened as radiation damage increases. The paper suggests methods to utilise the RIS in transmutation technology by dynamically segregating long life nuclides to preferred sites in the microstructure so that subsequent transmutations occur with maximum efficiency.

30170 (LBL–35470) **Atomic scale interface structure of $In_{0.2}Ga_{0.8}As$/GaAs strained layers studied by cross-sectional scanning tunneling microscopy.** Zheng, J.F. (Univ. of California, Berkeley, CA (United States). Dept. of Materials Science and Mineral Engineering); Weber, E.R.; Salmeron, M.B. Lawrence Berkeley Lab., CA (United States). Nov 1993. 6p. Sponsored by USDOE, Washington, DC (United States). DOE Contract AC03-76SF00098. (CONF-931108–115: Fall meeting of the Materials Research Society (MRS), Boston, MA (United States), 29 Nov - 3 dec 1993). Order Number DE96000127. Source: OSTI; NTIS; GPO Dep.

A molecular beam epitaxy-grown $In_{0.2}Ga_{0.8}As$/GaAs strained layer structure has been studied by scanning tunneling microscopy in cross-section on the (110) cleavage plane perpendicular to [001] the growth direction. Individual indium atoms were differentially imaged in the group III sublattice, allowing, a direct observation of the interface roughness due to the indium compositional fluctuation. In the $In_{0.2}Ga_{0.8}As$ layers, Indium atoms are found in clusters preferentially along the growth direction with each cluster containing 2–3 indium atoms. Indium segregation induced asymmetrical interface broadening is studied on an atomic scale. The interface of $In_{0.2}Ga_{0.8}As$ grown on GaAs is sharp within 2–4 atomic layers. The interface of GaAs grown on $In_{0.2}Ga_{0.8}As$ is found to be broadened to about 5–10 atomic layers. The atomic scale fluctuation due to indium distribution is about 20 Å alone the interface in this case. The authors conclude that clustering and segregation are the main reason for the $In_{0.2}Ga_{0.8}As$/GaAs interface roughness.

30171 (LBL–37481) **Theoretical study of the structure and electronic properties of carbon and $B_XC_YN_Z$ nanotubes.** Louie, S.G. (Univ. of California, Berkeley, CA (United States). Dept. of Physics). Lawrence Berkeley Lab., CA (United States). Jun 1995. 17p. Sponsored by USDOE, Washington, DC (United States);National Science Foundation, Washington, DC (United States). DOE Contract AC03-76SF00098. Grant DMR95-20554. (CONF-950624–1: Annual meeting of the American Society of Heating, Refrigeration and Air-Conditioning Engineers, Inc. (ASHRAE), San Diego, CA (United States), 24-28 Jun 1995). Order Number DE96000136. Source: OSTI; NTIS; GPO Dep.

Theoretical studies of the electronic and structural properties of carbon nanotubes and nanotubes composed of boron, carbon and nitrogen are presented. Structural stability, hybridization effects, static dielectric response, incorporation of metal atoms, and collapsed tube structures are calculated. Nanotubes of BN, BC_3, and BC_2N are predicted to form and have very different properties from those of the carbon systems. BN nanotubes are found to be constant band gap insulators with novel free-electron tubule states at the conduction band minimum. The possibility of chiral currents in doped BC_2N nanotubes is shown.

30172 (LBL–37525) **Surface recombination in semiconductors.** Langer, J.M. (Polish Academy of Sciences, Warsaw (Poland). Inst. of Physics); Walukiewicz, W. Lawrence Berkeley Lab., CA (United States). Jul 1995. 5p. Sponsored by USDOE, Washington, DC (United States). DOE Contract AC03-76SF00098. (CONF-9507172–2: 18. international conference on defects in semiconductors, Sendai (Japan), 23-28 Jul 1995). Order Number DE96001112. Source: OSTI; NTIS; GPO Dep.

We propose two general criteria for a surface defect state to act as an efficient, nonradiative recombination center. The first is that the thermal ionization energy should not deviate from the mid-gap

energy by more than the relaxation energy of the defect, In this case the activation energy for the recombination is given by the barrier for the capture of the first carrier, whereas the second carrier is captured athermally. The second citerion is related to the position of the average dangling bond energy relative to the band edges. If, as in the cases of InP or InAs, it is located close to a band edge, a low surface recombination velocity is expected. However a much faster recombination is predicated and experimentally observed in the materials with the average dangling bond energy located close to the mid-gap. The relevance of these criteria for the novel wide-gap optoelectronic materials is discussed.

30173 (LBL–37586) **Activation of shallow dopants in II-VI compounds.** Walukiewicz, W. Lawrence Berkeley Lab., CA (United States). Aug 1995. 15p. Sponsored by USDOE, Washington, DC (United States). DOE Contract AC03-76SF00098. (CONF-950874–2: 7. international conference on II-VI compounds and devices. Edinburgh (United Kingdom), 13-18 Aug 1995). Order Number DE96000125. Source: OSTI; NTIS; GPO Dep.

The amphoteric native defect model is applied to the understanding of the variations in the dopant activation efficiency in II-VI compounds. It is shown that the location of the common energy reference, the Fermi level stabilization energy, relative to the band edges can be used to determine the doping induced reduction of the formation energy and the enhancement of the concentration of compensating native defects. The model is applied to the most extensively studied compound semiconductors as well as to ternary and quaternary alloys. The effects of the compound ionicity on the dopant activation are briefly discussed.

30174 (LBL–37591) **High pressure studies on nanometer sized clusters: Structural, optical, and cooperative properties.** Tolbert, S.H. Lawrence Berkeley Lab., CA (United States). May 1995. 131p. Sponsored by USDOE, Washington, DC (United States). DOE Contract AC03-76SF00098. Order Number DE96001075. Source: OSTI; NTIS; GPO Dep.

High-pressure Se EXAFS is used to study pressure-induced structural transformations in CdSe nanocrystals. The transformation is wurtzite to rock salt, at a pressure much higher than in bulk. High-pressure XRD is used to confirm the EXAFS results. Diffraction peak widths indicate that nanocrystals do not fragment upon transformation. Optical absorption correlates with structural transformations and is used to measure transition pressures; transformation pressure increases smoothly as nanocrystal size decreases. Thermodynamics of transformation is modeled using an elevated surface energy in the high-pressure phase. High-pressure study of Si nanocrystals show large increases in transformation pressure in crystallites to 500Å diameter, and an overall change in crystallite shape upon transformation is seen from XRD line widths. C_{60} single crystals were studied using Raman scattering; results provide information about the clusters' rotational state. Optical properties of high-pressure phase CdSe clusters were studied.

30175 (ORNL–6874, pp. 45-56) **A novel carbon fiber based porous carbon monolith.** Burchell, T.D.; Klett, J.W.; Weaver, C.E. Oak Ridge National Lab., TN (United States). Jun 1995. In *Fossil Energy Program annual progress report for April 1994 through March 1995*. 203p. Order Number DE95015441. Source: OSTI; NTIS; GPO Dep.

A novel porous carbon material based on carbon fibers has been developed. The material, when activated, develops a significant micro- or mesopore volume dependent upon the carbon fiber type utilized (isotropic pitch or polyacrylonitrile). The materials will find applications in the field of fluid separations or as a catalyst support. Here, the manufacture and characterization of our porous carbon monoliths are described. A novel adsorbent carbon composite material has been developed comprising carbon fibers and a binder. The material, called carbon fiber composite molecular sieve (CFCMS), was developed through a joint research program between Oak Ridge National Laboratory (ORNL) and the University of Kentucky, Center for Applied Energy Research (UKCAER).

30176 (ORNL/TM–12963, pp. 137-142) **Aerogel nanocomposite materials.** Hunt, A.J. (Lawrence Berkeley Laboratory, CA (United States)); Ayers, M.; Cao, W. Oak Ridge National Lab., TN (United States). May 1995. In *Advanced Industrial Materials (AIM) Program. Annual progress report, FY 1994*. 341p. Order Number DE95016129. Source: OSTI; NTIS; GPO Dep.

Aerogels are porous, low density, nanostructured solids with many unusual properties including very low thermal conductivity, good transparency, high surface area, catalytic activity, and low sound velocity. This research is directed toward developing new nanocomposite aerogel materials for improved thermal insulation and several other applications. A major focus of the research has been to further increase the thermal resistance of silica aerogel by introducing infrared opacification agents into the aerogel to produce a superinsulating composite material. Opacified superinsulating aerogel permit a number of industrial applications for aerogel-based insulation. The primary benefits from this recently developed superinsulating composite aerogel insulation are: to extend the range of applications to higher temperatures, to provide a more compact insulation for space sensitive-applications, and to lower costs of aerogel by as much as 30%. Superinsulating aerogels can replace existing CFC-containing polyurethane in low temperature applications to reduce heat losses in piping, improve the thermal efficiency of refrigeration systems, and reduce energy losses in a variety of industrial applications. Enhanced aerogel insulation can also replace steam and process pipe insulation in higher temperature applications to substantially reduce energy losses and provide much more compact insulation.

30177 (ORNL/TM–12963, pp. 235-239) **Composites and blends from biobased materials.** Kelley, S.S. (National Renewable Energy Laboratory, Golden, CO (United States)). Oak Ridge National Lab., TN (United States). May 1995. In *Advanced Industrial Materials (AIM) Program. Annual progress report, FY 1994*. 341p. Order Number DE95016129. Source: OSTI; NTIS; GPO Dep.

The program is focused on the development of composites and blends from biobased materials to use as membranes, high value plastics, and lightweight composites. Biobased materials include: cellulose derivative microporous materials, cellulose derivative copolymers, and cellulose derivative blends. This year's research focused on developing an improved understanding of the molecular features that cellulose based materials with improved properties for gas separation applications. Novel cellulose ester membrane composites have been developed and are being evaluated under a collaborative research agreement with Dow Chemicals Company.

30178 (ORNL/TM–12963, pp. 241-249) **Conducting polymers: Synthesis and industrial applications.** Gottesfeld, S. (Los Alamos National Laboratory, NM (United States)). Oak Ridge National Lab., TN (United States). May 1995. In *Advanced Industrial Materials (AIM) Program. Annual progress report, FY 1994*. 341p. Order Number DE95016129. Source: OSTI; NTIS; GPO Dep.

The Conducting Polymer project funded by the AIM Materials Program is developing new methods for the synthesis of electronically conducting polymers and is evaluating new industrial applications for these materials which will result in significant reductions in energy usage or industrial waste. The applications specifically addressed during FY 1994 are electrochemical capacitors and membranes for gas separation. As an active material in electrochemical capacitors, conducting polymers have the potential of storing large amounts of electrical energy in low cost materials. Such devices are needed in electronics for power failure back-up and peak power, in power supplies for filtering, and in electric vehicles for peak power and load leveling. As a gas electrically adapt the membrane for specific gas combinations. Potential energy savings in the US. for this application are estimated at 1 to 3 quads/yr.

30179 (ORNL/TM–12963, pp. 251-256) **Magnetic field processing of inorganic polymers.** Kunerth, D.C. (Idaho National Engineering Laboratory, Idaho Falls, ID (United States)); Peterson, E.S. Oak Ridge National Lab., TN (United States). May 1995. In *Advanced Industrial Materials (AIM) Program. Annual progress report, FY 1994*. 341p. Order Number DE95016129. Source: OSTI; NTIS; GPO Dep.

The purpose of this project is to investigate, understand, and demonstrate the use of magnetic field processing (MFP) to modify the properties of inorganic-based polymers and to develop the basic technical knowledge required for industrial implementation. Polyphosphazene membranes for chemical separation applications are being emphasized by this project. Previous work demonstrated

that magnetic fields, appropriately applied during processing, can be used to beneficially modify membrane morphology. MFP membranes have significantly increased flux capabilities while maintaining the same chemical selectivity as the unprocessed membranes.

30180 (ORNL/TM–12963. pp. 257-267) **Polymerization and processing of organic polymers in a magnetic field.** Douglas, E.P. (Los Alamos National Laboratory, NM (United States)). Oak Ridge National Lab., TN (United States). May 1995. In *Advanced Industrial Materials (AIM) Program. Annual progress report, FY 1994.* 341p. Order Number DE95016129. Source: OSTI; NTIS; GPO Dep.

The use of magnetic fields to affect the structure and properties of polymeric materials remains an area of great promise. Liquid crystalline polymers have been actively studied over the past 20 years for use in high performance structural applications. In particular, highly oriented fibers can exhibit remarkable increases in strength to weight performance compared to conventional materials. For example, the fibers marketed by DuPont under the tradename Kevlar are 20 times stronger than steel on an equivalent weight basis. However, larger bulk parts do not exhibit the same increases in strength due to a lack of orientation of the polymer molecules. Magnetic field processing of polymers remains an attractive solution to this problem.

30181 (ORNL/TM–12963, pp. 271-274) **Advanced microwave processing concepts.** Lauf, R.J. (Oak Ridge National Laboratory, TN (United States)); McMillan, A.D.; Paulauskas, F.L. Oak Ridge National Lab., TN (United States). May 1995. In *Advanced Industrial Materials (AIM) Program. Annual progress report, FY 1994.* 341p. Order Number DE95016129. Source: OSTI; NTIS; GPO Dep.

The purpose of this work is to explore the feasibility of several advanced microwave processing concepts to develop new energy-efficient materials and processes. The project includes two tasks: (1) commercialization of the variable-frequency microwave furnace; and (2) microwave curing of polymer composites. The variable frequency microwave furnace, whose initial conception and design was funded by the AIC Materials Program, will allow us, for the first time, to conduct microwave processing studies over a wide frequency range. This novel design uses a high-power traveling wave tube (TWT) originally developed for electronic warfare. By using this microwave source, one can not only select individual microwave frequencies for particular experiments, but also achieve uniform power densities over a large area by the superposition of many different frequencies. Microwave curing of thermoset resins will be studied because it hold the potential of in-situ curing of continuous-fiber composites for strong, lightweight components. Microwave heating can shorten curing times, provided issues of scaleup, uniformity, and thermal management can be adequately addressed.

30182 (ORNL/TM–12963, pp. 275-278) **Biomimetic thin film synthesis.** Graff, G.L.; Campbell, A.A.; Gordon, N.R. Oak Ridge National Lab., TN (United States). May 1995. In *Advanced Industrial Materials (AIM) Program. Annual progress report, FY 1994.* 341p. Order Number DE95016129. Source: OSTI; NTIS; GPO Dep.

The purpose of this program is to develop a new process for forming thin film coatings and to demonstrate that the biomimetic thin film technology developed at PNL is useful for industrial applications. In the biomimetic process, mineral deposition from aqueous solution is controlled by organic functional groups attached to the underlying substrate surface. The coatings process is simple, benign, inexpensive, energy efficient, and particularly suited for temperature sensitive substrate materials (such as polymers). In addition, biomimetic thin films can be deposited uniformly on complex shaped and porous substrates providing a unique capability over more traditional line-of-sight methods.

30183 (SAND–95-1958C) **Effects of solution precursor nature on sol-gel derived PZT thin film crystallization behavior and properties.** Schwartz, R.W.; DaSalla, R.S. Sandia National Labs., Albuquerque, NM (United States). [1995]. 6p. Sponsored by USDOE, Washington, DC (United States). DOE Contract AC04-94AL85000. (CONF-9511122–1: 7. U.S.-Japan seminar on dielectric and piezoelectric ceramics, Tsukuba (Japan), 15-17 Nov 1995). Order Number DE95017573. Source: OSTI; NTIS; GPO Dep.

In fabricating lead zirconate titanate (PZT) films for nonvolatile memories and decoupling capacitors, various deposition methods have been investigated. Each can produce films with acceptable dielectric and ferroelectric properties, but sol-gel methods offer excellent control of film stoichiometry and coating uniformity. The sol-gel approaches for PZT film fabrication fall into two categories: processes that use 2-methoxyethanol as a solvent, and processes that use chelating agents, such as acetic acid, for reducing the hydrolysis sensitivity of the alkoxide compounds. Due to concerns about the toxicity of 2-methoxyethanol, we have concentrated on the second category. It was found that, in addition to reducing the hydrolysis sensitivity, the chelating agents serves to define the processing behavior of the films: film consolidation after deposition and densification and crystallization during heat treatment. This paper discusses the relations between precursor structure (reactions between chelating agents and the metal alkoxide starting reagents) and film consolidation, densification, and crystallization.

30184 (UCRL-ID–118940) **Descriptions of positron defect analysis capabilities.** Howell, R.H. Lawrence Livermore National Lab., CA (United States). Oct 1994. 10p. Sponsored by USDOE, Washington, DC (United States). DOE Contract W-7405-ENG-48. Order Number DE96000841. Source: OSTI; NTIS; INIS; GPO Dep.

A series of descriptive papers and graphics appropriate for distribution to potential collaborators has been assembled. These describe the capabilities for defect analysis using positron annihilation spectroscopy. The application of positrons to problems in the polymer and semiconductor industries is addressed.

30185 (UCRL-ID–119645) **Sources of strain in rapidly grown crystals of KH_2PO_4.** De Yoreo, J. (and others); Zaitseva, N.; Woods, B. Lawrence Livermore National Lab., CA (United States). Feb 1995. 4p. Sponsored by USDOE, Washington, DC (United States). DOE Contract W-7405-ENG-48. Order Number DE95017863. Source: OSTI; NTIS; GPO Dep.

The objective of this paper is to describe the results of x-ray topographic studies on potassium di-hydro phosphate (KDP) crystals grown from solutions at high supersaturation which produces growth rates of ten to fifty times those of conventional methods. Strain in the crystals is discussed.

30186 (UCRL-ID–121332) **EGDM foam shell status report (TAT 95-049).** Lambert, S.; Overturf, G.; Cook, B.; Schroen-Carey, D. Lawrence Livermore National Lab., CA (United States). 27 Jun 1995. 11p. Sponsored by USDOE, Washington, DC (United States). DOE Contract W-7405-ENG-48. Order Number DE95017899. Source: OSTI; NTIS; GPO Dep.

We have completed an investigation of a low density foam made from ethylene glycol dimethacrylate (EGDM). We are confident that we have attained foam properties similar to those reported by Osaka, such as foam density (~60 mg/cc) and visibility of optical interference fringes. However, the material undergoes significant shrinkage during supercritical CO_2 drying which hinders additional target fabrication steps. We also discuss issues related to preparing shells using a droplet generator and overcoating this material with hydroxyethyl cellulose.

30187 (UCRL-ID–121651) **A procedure for diamond turning KDP crystals.** Montesanti, R.C.; Thompson, S.L. USDOE Economic Regulatory Administration, Washington, DC (United States). Coal and Electricity Div. 7 Jul 1995. 9p. Sponsored by USDOE, Washington, DC (United States). DOE Contract W-7405-ENG-48. Order Number DE95017897. Source: OSTI; NTIS; GPO Dep.

A procedure and the equipment necessary for single-point diamond flycutting (loosely referred to as diamond turning) potassium di-hydrogen phosphate (KDP) crystals are described. It is based on current KDP diamond turning activities at the Lawrence Livermore National Laboratory (LLNL), drawing upon knowledge from the Nova crystal finishing development during the 1980's and incorporating refinements from our efforts during 1995. In addition to describing a step-by-step process for diamond turning KDP, specific discussions are included on the necessary diamond tool

geometry and edge sharpness, cutting fluid, and crystal preparation, handling, cleaning, and inspection. The authors presuppose that the reader is already familiar with diamond turning practices.

30188 (UCRL-JC–120315) **Synthesis, characterization, and modeling of hydrogen storage in carbon aerogels.** Pekala, R.W.; Coronado, P.R.; Calef, D.F. Lawrence Livermore National Lab., CA (United States). Apr 1995. 15p. Sponsored by USDOE, Washington, DC (United States). DOE Contract W-7405-ENG-48. (CONF-9504160–8: 1995 DOE/NREL hydrogen program review, Coral Gables, FL (United States), 18-21 Apr 1995). Order Number DE95017841. Source: OSTI; NTIS; GPO Dep.

Carbon aerogels are a special class of open-cell foams with an ultrafine cell/pore size (<50 nm), high surface area (600-800 m^2/g), and a solid matrix composed of interconnected colloidal-like particles or fibers with characteristic diameters of 10 nm. These materials are usually synthesized from the sol-gel polymerization of resorcinol-formaldehyde or phenolic-furfural, followed by supercritical extraction of the solvent and pyrolysis in an inert atmosphere. The resultant aerogel has a nanocrystalline structure with micropores (<2 nm diameter) located within the solid matrix. Carbon aerogel monoliths can be prepared at densities ranging from 0.05-1.0 g/cm^3, leading to volumetric surface areas (> 500 m^2/cm^3) that are much larger than commercially available materials. This research program is directed at optimization of the aerogel structure for maximum hydrogen adsorption over a wide range of temperatures and pressures. Computer modeling of hydrogen adsorption at carbon surfaces was also examined.

30189 (UCRL-JC–120817) **Selective Au-Si eutectic bonding for Si-based MEMS applications.** Lee, A. (and others); Lehew, S.; Yu, C. Lawrence Livermore National Lab., CA (United States). 22 May 1995. 12p. Sponsored by USDOE, Washington, DC (United States). DOE Contract W-7405-ENG-48. (CONF-950518–15: 187. meeting of the Electrochemical Society, Reno, NV (United States), 21-26 May 1995). Order Number DE95017294. Source: OSTI; NTIS; GPO Dep.

A novel method of fabricating three-dimensional silicon micro electromechanical systems (MEMS) is presented, using selectivity thin film deposited Au-Si eutectic bond pads. Utilizing this process, complicated structures such as microgrippers and microchannels are fabricated. Bond strengths are higher than the silicon fracture strength and the bond areas can be localized and aligned to the processed wafer. The process and the applications are described in this paper.

30190 (UCRL-JC–121193) **Dymalloy: A composite substrate for high power density electronic components.** Kerns, J.A. (Lawrence Livermore National Lab., CA (United States)); Colella, N.J.; Makowiecki, D.; Davidson, H.L. Lawrence Livermore National Lab., CA (United States). 29 Jun 1995. 10p. Sponsored by USDOE, Washington, DC (United States). DOE Contract W-7405-ENG-48. (CONF-9510190–1: 28. international symposium on microelectronics: showcasing the stars of microelectronics and 1. international symposium on ball grid array, Los Angeles, CA (United States), 22-26 Oct 1995). Order Number DE96000395. Source: OSTI; NTIS; GPO Dep.

High power density electronic components such as fast microprocessors and power semiconductors must operate below the maximum rated device junction temperature to ensure reliability. function temperatures are determined by the amount of heat generated and the thermal resistance from junction to the ambient thermal environment. Two of the Largest contributions to this thermal resistance are the die attach interface and the package base. A decrease in these resistances can allow increased component packing density in MCMs, reduction of heat sink volume in tightly packed systems, enable the use of higher performance circuit components, and improve reliability. The substrate for high power density devices is the primary thermal link between the junctions and the heat sink. Present high power multichip modules and single chip packages use substrate materials such as silicon nitride or copper tungsten that have thermal conductivity in the range of 200 W/mK. We have developed Dymalloy, a copper-diamond composite, that has a thermal conductivity of 420 W/mK and an adjustable coefficient of thermal expansion, nominally 5.5 ppm/C at 25 C, compatible with silicon and gallium arsenide. Because of the matched coefficient of thermal expansion it is possible to use low thermal resistance hard die attach methods. Dymalloy is a composite material made using micron size Type I diamond powder that has a published thermal conductivity of 600 to 1000 W/mK in a metal matrix that has a thermal conductivity of 350 W/mK. The region of chemical bonding between the matrix material and diamond is limited to approximately 1000 A to maintain a high effective thermal conductivity for the composite. The material may be fabricated in near net shapes. Besides having exceptional thermal properties, the mechanical properties of this material also make it an attractive candidate as an electronic component substrate material.

30191 (UCRL-JC–121235) **Accelerated degradation studies of MEH-PPV.** Radousky, H.B.; Madden, A.D.; Pakbaz, K.; Hagler, T.W.; Lee, H.W.H.; Lorenzana, H.E.; Fox, G.A.; Elliker, P.R. Lawrence Livermore National Lab., CA (United States). Jul 1995. 6p. Sponsored by USDOE, Washington, DC (United States). DOE Contract W-7405-ENG-48. (CONF-951033–9: 27. international technical conference of the Society for the Advancement of Material and Process Engineering (SAMPE): diversity into the next century, Albuquerque, NM (United States), 9-12 Oct 1995). Order Number DE95015892. Source: OSTI; NTIS; GPO Dep.

MEH-PPV, which normally has a reddish color, is well known to show photobleaching problems. The photobleaching can be greatly accelerated by exposure to laser light while in air. For example, shining 457 mn light of relatively low intensity (0.06 W/cm^2) on the MEH-PPV causes the photoluminescence to decrease by a factor of two within a few seconds of exposure, and to show a nearly complete bleaching of the material within 30 minutes. The degradation rate is strongly influenced by laser power, sample thickness, oxygen exposure during preparation and spinning, as well as the oxygen environment during the measurement. The photobleach is indicative of one class of degradation mechanisms limiting the usefulness of PPV based polymers in electroluminescent devices. MEH-PPV which was spin coated in a nitrogen environment and measured in vacuum showed no measurable photo-chemical degradation for measuring times of up to several hours. A dramatic decrease in PL intensity was observed, however, in the presence of oxygen, as well as in samples spin coated in air, but measured in vacuum. We present data on the PL of MEH-PPV, as a function of oxygen concentration.

30192 (UCRL-JC–121620) **Defects and morphological concerns in electroluminescent polymers.** Yan, M. (Lawrence Livermore National Lab., CA (United States)); Rothberg, L.; Galvin, M.E. Lawrence Livermore National Lab., CA (United States). 24 Jul 1995. 10p. Sponsored by USDOE, Washington, DC (United States). DOE Contract W-7405-ENG-48. (CONF-951033–21: 27. international technical conference of the Society for the Advancement of Material and Process Engineering (SAMPE): diversity into the next century, Albuquerque, NM (United States), 9-12 Oct 1995). Order Number DE95017870. Source: OSTI; NTIS; INIS; GPO Dep.

The degradation of luminescence in phenylenevinylene polymers is due to exciton diffusion to quenching defects. The microscopic structure of these defects is identified by in-situ vibrational spectroscopy. The authors present evidence that the defect quenching is due to charge transfer by studies on model phenylenevinylene oligomer. In the absence of defect quenchers, the authors have achieved nearly exponential photoluminescence decay with observed lifetimes > 1 ns and a fourfold increase in electroluminescence. They have also utilized picosecond laser spectroscopy to study the formation yield of emissive excitons in the polymer PPVs with different morphology. They have found that increasing polymer chain separation would greatly increases the luminescent efficiency due to avoiding the interchain excitons (exciplexes). Clarification of the nature of photophysics of conjugated polymers suggests avenues for improvement in fabrication of emissive polymers and electroluminescent polymers devices.

30193 (UCRL-JC–121658) **Performance evaluation of bound diamond ring tools.** Piscotty, M.A.; Taylor, J.S.; Blaedel, K.L. Lawrence Livermore National Lab., CA (United States). 14 Jul 1995. 16p. Sponsored by USDOE, Washington, DC (United States). DOE Contract W-7405-ENG-48. (CONF-950793–39: 40.

annual meeting of the Society of Photo-Optical Instrumentation Engineers, San Diego, CA (United States), 9-14 Jul 1995). Order Number DE95017820. Source: OSTI; NTIS; GPO Dep.

LLNL is collaborating with the Center for Optics Manufacturing (COM) and the American Precision Optics Manufacturers Association (APOMA) to optimize bound diamond ring tools for the spherical generation of high quality optical surfaces. An important element of this work is establishing an experimentally-verified link between tooling properties and workpiece quality indicators such as roughness, subsurface damage and removal rate. In this paper, we report on a standardized methodology for assessing ring tool performance and its preliminary application to a set of commercially-available wheels. Our goals are to (1) assist optics manufacturers (users of the ring tools) in evaluating tools and in assessing their applicability for a given operation, and (2) provide performance feedback to wheel manufacturers to help optimize tooling for the optics industry. Our paper includes measurements of wheel performance for three 2-4 micron diamond bronze-bond wheels that were supplied by different manufacturers to nominally-identical specifications. Preliminary data suggests that the difference in performance levels among the wheels were small.

30194 (UM-P–94/123) **Principles for structure analysis of carbon nanotubes by HRTEM.** Fan Xudong; Bursill, L.A. Melbourne Univ., Parkville, VIC (Australia). School of Physics. [1995]. 30p. Sponsored by Australian Research Council, Canberra, ACT (Australia). Order Number DE96602569. Source: OSTI; NTIS; INIS.

An efficient algorithm is derived for generating all possible seamless carbon nanotube structure models. This makes use of multijugate helical lattices, a concept borrowed from some biological structures. Principles for helicity and structure analysis of carbon nanotubes using high-resolution electron microscopy and image processing techniques are then developed. Applicability is tested on experimentally obtained images. The limitations of this approach are examined. Provided the tubules contain less than three to five layers the individual component layer helicities and the order of assembly may be obtained from the high-resolution many-beam bright - and dark-field image reconstructions. 16 refs., 11 figs.

30195 (UM-P–95/16) **Studies of defects on ion irradiated diamond.** Lai, P.F. (Melbourne Univ., Parkville, VIC (Australia). School of Physics); Prawer, S.; Spargo, A.E.C.; Bursill, L.A.; Noble, C. Melbourne Univ., Parkville, VIC (Australia). School of Physics. 1995. 8p. Order Number DE96602570. Source: OSTI; NTIS; INIS.

It has recently been shown that successful doping of diamond involves implantation a low temperatures followed by rapid thermal annealing and that the degree of activation depends on a competition between C interstitial-vacancy recombination and implanted dopant-vacancy combination. A knowledge of the defect structures created in the diamond is therefore crucial for optimizing the doping of diamond by ion irradiation. In the present work, type IIa diamond has been irradiated with 320 keV Xe ions at room temperature. It was found that up to a dose of 1×10^{14} ions/cm^2, the diamond remains single crystalline, with no evidence of graphitization. TEM results are supplemented with EELS, Raman spectroscopy, ESR and electrical conductivity measurements, to provide a comprehensive picture of the defect structure in the ion implanted layer. 13 refs., 1 tab., 4 figs.

30196 (UM-P–95/17) **The effect of ion-beam induced strain on the nucleation density of chemical vapour deposited diamond.** Weiser, P.S.; Prawer, S.; Nugent, K.W.; Bettiol, A.A.; Kostidis, L.I.; Jamieson, D.N. Melbourne Univ., Parkville, VIC (Australia). School of Physics. 1995. 5p. Order Number DE96602575. Source: OSTI; NTIS; INIS.

The effect of ion implantation on the nucleation of CVD diamond on silicon and diamond substrates has been investigated. The strategy employed is to create laterally confined regions of strain in the substrates by focused MeV implantation of light ions. Raman Microscopy has been employed to obtain spatially resolved maps of the strain in these implanted regions. On diamond substrates a homo-epitaxial CVD diamond film was grown on top of both the implanted and unimplanted regions of the substrate. Raman analysis of the film grown on top of the implanted region revealed it to be under slightly tensile strain as compared to that grown on the unimplanted diamond substrate. The film deposited on the implanted portion of the diamond showed a lower fluorescence background; indicating a lower concentration of incorporated defects. These results suggest that the strain and defects in the diamond substrate material have an important influence on the quality of the homo-epitaxially grown diamond films. 6 refs., 5 figs.

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Refer also to citation(s) 29847

4001 Analytical and Separations Chemistry

Refer also to citation(s) 28769, 28806, 28907, 28919, 28920, 28926, 28927, 28928, 28939, 28945, 28952, 28954, 28955, 28957, 28959, 29151, 29155, 29156, 29556, 29557, 29558, 29559, 29560, 29568, 29799, 29853, 30056, 30082, 30110, 30135, 30233, 30234, 30254, 30255, 30258, 30260, 30261, 30262, 30263, 30264, 30265, 30266, 30267, 30268, 30269, 30270, 30271, 30272, 30274, 30472, 30553, 30636, 30685, 30712, 30717, 30752, 30903

30197 (ANL/CHM/CP–85678) **In situ analysis of thin film deposition processes using time-of-flight (TOF) ion beam analysis methods.** Im, J. (Argonne National Lab., IL (United States)); Krauss, A.R.; Gruen, D.M.; Lin, Y.; Schultz, J.A.; Auciello, O.H. Argonne National Lab., IL (United States). May 1995. 29p. Sponsored by USDOE, Washington, DC (United States). DOE Contract W-31-109-ENG-38. (CONF-9505122–3: International conference on ion beam analysis, Tempe, AZ (United States), 22-26 May 1995). Order Number DE95013546. Source: OSTI; NTIS; INIS; GPO Dep.

Non-destructive, in situ methods for characterization of thin film growth phenomena is key to understand thin film growth processes and to develop more reliable deposition procedures, especially for complex layered structures involving multi-phase materials. However, surface characterization methods that use either electrons (e.g. AES or XPS) or low energy ions (SIMS) require an UHV environment and utilize instrumentation which obstructs line of sight access to the substrate and are therefore incompatible with line of sight deposition methods and thin film deposition processes which introduce gas, either part of the deposition or in order to produce the desired phase. We have developed a means of differentially pumping both the ion beam source and detectors of a TOF ion beam surface analysis spectrometer that does not interfere with the deposition process and permits compositional and structural analysis of the growing film in the present system, at pressures up to several mTorr. Higher pressures are feasible with modified source-detector geometry. In order to quantify the sensitivity of Ion Scattering Spectroscopy (ISS) and Direct Recoil Spectroscopy (DRS), we have measured the signal intensity for stabilized clean metals in a variety of gas environments as a function of the ambient gas species and pressure, and ion beam species and kinetic energy. Results are interpreted in terms of collision cross sections which are compared with known gas phase scattering data and provide an apriori basis for the evaluation of time-of-flight ion scattering and recoil spectroscopies (ToF-ISARS) for various industrial processing environments which involve both inert and reactive cases. The cross section data for primary ion-gas molecule and recoiled atom-gas molecule interactions are also provided. from which the maximum operating pressure in any experimental configuration can be obtained.

30198 (BNL–62155) **Remote detection of trace effluents using Resonance Raman spectroscopy: Field results and evaluation.** Sedlacek, A.J.; Chen, C.L. Brookhaven National Lab., Upton, NY (United States). [1995]. 8p. Sponsored by USDOE, Washington, DC (United States). DOE Contract AC02-76CH00016. (CONF-9510221–1: ONDCP international technology symposium, Nashua, NH (United States), 24-27 Oct 1995; SSN–95-34). Order Number DE96000424. Source: OSTI; NTIS; GPO Dep.

Resonance Raman spectroscopy (RRS) possesses many characteristics that are important for detecting, identifying and monitoring chemical effluents. Raman scattering is a coherent, inelastic, two-photon scattering process where an exciting photon of energy $h\nu$ promotes a molecule to a virtual level and the subsequently

emitted photon is shifted in frequency in accordance with the rotational-vibrational structure of the irradiated species, thereby providing a unique fingerprint of the molecule. Under resonance enhancement, the Raman scattering cross-sections have been observed to increase up to 6 orders of magnitude above the normal scattering cross-sections, thereby providing the practical basis for a remote chemical sensor. Some of the other advantages that a Raman sensor possesses are: (1) very high selectivity (chemical specific fingerprints), (2) independence of the spectral fingerprint on the excitation wavelength (ability to monitor in the solar blind region), (3) chemical mixture fingerprints are the sum of its individual components (no spectral cross-talk), (4) near independence of the Raman fingerprint to its physical state (very similar spectra for gas, liquid, solid or solutions), (5) no absolute calibration is necessary because all Raman signals observed from a given species can be compared with the Raman signal for N_2, whose concentration is known very accurately, and (6) insensitivity of the Raman signature to environmental conditions (no quenching, or interference from water vapor). In this presentation, the technology of resonance Raman spectroscopy as applied to the detection of narcotics production activities will be presented along with some recent experimental results.

30199 (INIS-BR–3549) **Dating by fission track method: study of neutron dosimetry with natural uranium thin films.** Iunes, P.J. Universidade Estadual de Campinas, SP (Brazil). Inst. de Fisica. Jun 1990. 102p. (In Portuguese). Order Number DE96602455. Source: OSTI; NTIS; INIS.

Fission track dating is described, focalizing the problem of the decay constant for spontaneous fission of ^{238} U and the use of neutron dosimetry in fission track analysis. Experimental procedures using thin films of natural uranium as neutron dosimeters and its results are presented. The author shows a intercomparison between different thin films and between the dosimetry with thin film and other dosimetries. (M.V.M.). 52 refs, 12 figs, 9 tabs.

30200 (INIS-mf–14594) **Genotoxic valuation of Zinalco, a zinc base alloy, by the mutation and somatic recombination test in Drosophila Melanogaster.** Ramirez V, P. Universidad Nacional Autonoma de Mexico, Mexico City (Mexico). Facultad de Ciencias. 1995. 78p. (In Spanish). Order Number DE96602454. Source: OSTI; NTIS (US Sales Only); INIS.

Zinalco is an eutectoid alloy made of zinc, aluminium and copper (78% , 20% and 2%), because of its physical, chemical and mechanical characteristics, it has been established as a structural material and valued as a feasible bio material. Previous authors have studies on the cytotoxic effect of Zinalco, so for concluded that it is harmless to the organism. However, was considered necessary to evaluate its potential genotoxicity. The present work was done with the fruit fly Drosophila Melanogaster. The objectives were: to determine the administered particle size, to evaluate its ingestion zinalco and to score the genotoxic effect by means of the SMART test in wing cells of D. Melanogaster. The protocol consisted of an oral chronic treatment, to groups of 72th age larvae, with concentrations of 0,1,2,4,8 and 16 mg of zinalco in ml of water on 1.5 g of synthetic medium. Statistical analysis was done through the SMART program. The results obtained showed an average particle size of 16 m long x 5.9 m wide. The normal amount of the alloy elements in the larvae was increased and finally, no genotoxicity at any of the administered doses could be detected. (Author).

30201 (IS-T–1740) **New electrolyte systems for capillary zone electrophoresis of metal cations and non-ionic organic compounds.** Shi, Y. Ames Lab., IA (United States). 19 Jun 1995. 135p. Sponsored by USDOE, Washington, DC (United States). DOE Contract W-7405-ENG-82. Order Number DE96000217. Source: OSTI; NTIS; GPO Dep.

Excellent separations of metal ions can be obtained very quickly by capillary electrophoresis provided a weak complexing reagent is incorporated into the electrolyte to alter the effective mobilities of the sample ions. Indirect photometric detection is possible by also adding a UV-sensitive ion to the electrolyte. Separations are described using phthalate, tartrate, lactate or hydroxyisobutyrate as the complexing reagent. A separation of twenty-seven metal ions was achieved in only 6 min using a lactate system. A mechanism for the separation of lanthanides is proposed for the hydroxyisobutyrate system.

30202 (IS-T–1742) **Matrix effects in inductively coupled plasma mass spectrometry.** Chen, Xiaoshan. Ames Lab., IA (United States). 7 Jul 1995. 130p. Sponsored by USDOE, Washington, DC (United States). DOE Contract W-7405-ENG-82. Order Number DE96000215. Source: OSTI; NTIS; INIS; GPO Dep.

The inductively coupled plasma is an electrodeless discharge in a gas (usually Ar) at atmospheric pressure. Radio frequency energy generated by a RF power source is inductively coupled to the plasma gas through a water cooled load coil. In ICP-MS the "Fassel" TAX quartz torch commonly used in emission is mounted horizontally. The sample aerosol is introduced into the central flow, where the gas kinetic temperature is about 5000 K. The aerosol is vaporized, atomized, excited and ionized in the plasma, and the ions are subsequently extracted through two metal apertures (sampler and skimmer) into the mass spectrometer. In ICP-MS, the matrix effects, or non-spectroscopic interferences, can be defined as the type of interferences caused by dissolved concomitant salt ions in the solution. Matrix effects can be divided into two categories: (1) signal drift due to the deposition of solids on the sampling apertures; and/or (2) signal suppression or enhancement by the presence of the dissolved salts. The first category is now reasonably understood. The dissolved salts, especially refractory oxides, tend to deposit on the cool tip of the sampling cone. The clogging of the orifices reduces the ion flow into the ICP-MS, lowers the pressure in the first stage of ICP-MS, and enhances the level of metal oxide ions. Because the extent of the clogging increases with the time, the signal drifts down. Even at the very early stage of the development of ICP-MS, matrix effects had been observed. Houk et al. found out that the ICP-MS was not tolerant to solutions containing significant amounts of dissolved solids.

30203 (LA-UR–95-1805) **Improving shuffler assay accuracy.** Rinard, P.M. Los Alamos National Lab., NM (United States). [1995]. 6p. Sponsored by USDOE, Washington, DC (United States). DOE Contract W-7405-ENG-36. (CONF-950787–55: 36. annual meeting of the Institute for Nuclear Materials Management, Palm Desert, CA (United States), 9-12 Jul 1995). Order Number DE95015312. Source: OSTI; NTIS; INIS; GPO Dep.

Drums of uranium waste should be disposed of in an economical and environmentally sound manner. The most accurate possible assays of the uranium masses in the drums are required for proper disposal. The accuracies of assays from a shuffler are affected by the type of matrix material in the drums. Non-hydrogenous matrices have little effect on neutron transport and accuracies are very good. If self-shielding is known to be a minor problem, good accuracies are also obtained with hydrogenous matrices when a polyethylene sleeve is placed around the drums. But for those cases where self-shielding may be a problem, matrices are hydrogenous, and uranium distributions are non-uniform throughout the drums, the accuracies are degraded. They can be greatly improved by determining the distributions of the uranium and then applying correction factors based on the distributions. This paper describes a technique for determining uranium distributions by using the neutron count rates in detector banks around the waste drum and solving a set of overdetermined linear equations. Other approaches were studied to determine the distributions and are described briefly. Implementation of this correction is anticipated on an existing shuffler next year.

30204 (LA-UR–95-3380) **Feasibility study of plutonium and uranium measurements in input dissolver solutions.** Li, T.K. (Los Alamos National Lab., NM (United States)); Kitagawa, O.; Kuno, Y.; Kurosawa, A. Los Alamos National Lab., NM (United States). [1995]. 7p. Sponsored by USDOE, Washington, DC (United States). DOE Contract W-7405-ENG-36. (CONF-950923–11: 5. international conference on facility-safeguards interface, Jackson Hole, WY (United States), 24-30 Sep 1995). Order Number DE96001374. Source: OSTI; NTIS; GPO Dep.

We are studying the isotope dilution gamma-ray spectrometry (IDGS) technique for the simultaneous measurements of concentrations and isotopic compositions for both plutonium and uranium in spent-fuel dissolver solutions at a reprocessing plant. Previous

experiments have demonstrated that the IDGS technique can determine the elemental concentrations and isotopic compositions of plutonium in dissolver solutions. The chemical separation and recovery methods for just plutonium were ion-exchange techniques using anion exchange resin beads and filter papers. To keep both plutonium and uranium in the sample for simultaneous measurements, a new sample preparation method is being studied and developed: extraction chromatography. The technique uses U/TEVA-Spec resin to separate fission products and recover both uranium and plutonium in the resin from dissolver solutions for measurements by high-resolution gamma-ray spectrometry.

30205 (LBL–37309) **Photoelectron holography applied to surface structural determination.** Petersen, B.L. Lawrence Berkeley Lab., CA (United States). May 1995. 175p. Sponsored by USDOE, Washington, DC (United States). DOE Contract AC03-76SF00098 ; AC02-76CH00016 ; W-7405-ENG-48. Order Number DE96000111. Source: OSTI; NTIS; GPO Dep.

Photoemitted electron waves are used as coherent source waves for angstrom-scale holographic imaging of local atomic geometry at surfaces. Electron angular distribution patterns are collected above a sample surface and serve as a record of the interference between source wave and waves scattered from surrounding ion cores. Using a mathematical imaging integral transformation, the three-dimensional structural information is obtained directly from these collected patterns. Patterns measured with different electron kinetic energies are phase-summed for image improvement. Pt (111) surface is used as a model system. A pattern $9.6Å^{-1}$ (351 eV) is used to generate a full 3-D image of atom locations around an emitter with nearest neighbors within 0.1Å of the expected bulk positions. Atoms several layers beyond the nearest neighbors are also apparent. Twin-image reduction and artifact suppression is obtained by phase-summing eight patterns measured from 8.8 to $10.2Å^{-1}$ (295 to 396 eV). 32 were measured in $0.2Å^{-1}$ steps from 6.0 to $12.2Å^{-1}$ (137 to 567 eV) are presented here. Simple models of two-slit interference are compared with electron scattering to illuminate understanding of holographic recording of the structural information. This also shows why it sometimes fails due to destructive interferences. Simple theoretical models of electron scattering are compared to experiment to show the origin of the structural information and the differences that result from atomic scattering and from the source wave. Experimental parameters and their relation to imaging is discussed. Comparison is made to the Pt pattern measured at 351 eV using the simple theoretical model. The remaining data set is also modeled, and the eight appropriate theoretical patterns are used to regenerate the multiple-wavenumber experimental result. A clean Cu (001) surface is also measured and imaged.

30206 (MLM–105) **The identification of complex ions in solution by spectrophotometric measurements.** Staniforth, R.A. Mound Lab., Miamisburg, OH (United States). 18 May 1948. 8p. Sponsored by USDOE, Washington, DC (United States). DOE Contract AC04-76DP00053. Order Number DE96001404. Source: OSTI; NTIS; GPO Dep.

A theoretical discussion of the formation and steady state kinetic behavior of metal complexes is provided.

30207 (MLM–109) **A study of the quartz fiber balance No. II.** Nelson, G.A. Mound Lab., Miamisburg, OH (United States). 11 Apr 1946. 10p. Sponsored by USDOE, Washington, DC (United States). DOE Contract AC04-76DP00053. Order Number DE96001400. Source: OSTI; NTIS; GPO Dep.

This report describes calibration studies for the quartz microbalance #2 and problems with drift.

30208 (MLM–122) **Quartz fiber research progress report. May 1–31, 1948.** Olt, R.G. Mound Lab., Miamisburg, OH (United States). [1948]. 4p. Sponsored by USDOE, Washington, DC (United States). DOE Contract AC04-76DP00053. Order Number DE96001401. Source: OSTI; NTIS; GPO Dep.

This document describes the construction and calibration of a quartz fiber microbalance. The preparation and purification of diphenyl carbazide for use as a cement with the quartz fibers is also described.

30209 (MLM–146) **A new device for filtering hydrofluoric acid and other strong acids. Information report.** Bell, R. Monsanto Chemical Co., Dayton, OH (United States). 9 Jul 1948. 5p. Sponsored by USDOE, Washington, DC (United States). DOE Contract AC24-88DP43495. Order Number DE96000801. Source: OSTI; NTIS; GPO Dep.

During the course of a research problem involving hydrofluoric acid it became necessary to filter concentrated hydrofluoric solutions to remove various solid materials. The search for a suitable filter media finally led to the use of a commercially manufactured plastic material known as "Sponge Teflon" (polytetrafluoroethylone) which is produced by the DuPont Company. This material, which comes in 1/8 in. sheets, is used primarily as a gasket material in acid lines, and is impervious to all acids, including hydrofluorle acid.

30210 (MLM–162) **Laboratory instrument design progress report, July 1–31, 1948.** Olt, R.G. Mound Lab., Miamisburg, OH (United States). [1948]. 5p. Sponsored by USDOE, Washington, DC (United States). DOE Contract AC04-76DP00053. Order Number DE96001402. Source: OSTI; NTIS; GPO Dep.

One current model Ryerson quartz-fiber microbalance fitted with a quartz-fiber beam but lacking the entire optical system was received from Argonne National Laboratory on June 30, 1948. The first trails of the fiber drawing machine indicated excessive vibration originating in the motorized variable-speed transmissions and accentuated by the machine frame. Isolation of the motorized transmission vibrations from the drawing machine permitted successful drawing on first trials of the eight diameters of fibers between 750 and 5 microns needed for balance beam construction. Each trial yielded a full reel (approximately 150 feet) of usable fiber, through storage facilities were inadequate to preserve the entire quantity.

30211 (MLM–170) **Colorimetric determination of nickel in postum solutions.** Rogers, N.E.; Payne, J.H. Jr. Mound Lab., Miamisburg, OH (United States). 17 Aug 1948. 5p. Sponsored by USDOE, Washington, DC (United States). DOE Contract AC04-76DP00053. Order Number DE96001426. Source: OSTI; NTIS; GPO Dep.

Validity of the colorimetric determination of nickel in solutions containing 1.5 N nitric acid and 0.3 c. postum (Polonium 210) per ml. was confirmed.

30212 (NREL/CP–433-7748, pp. 1-6) **Free jet sampling - a motley mix of methods and applications.** Fenn, J.B. (Virginia Commonwealth Univ., Richmond, VA (United States)). National Renewable Energy Lab., Golden, CO (United States). Mar 1995. (CONF-9410343–: Applications of free-jet, molecular beam, mass spectrometric sampling conference, Estes Park, CO (United States), 11-14 Oct 1994). In *Applications of free-jet, molecular beam, mass spectrometric sampling: Proceedings.* 305p. Order Number DE95004052. Source: OSTI; NTIS; GPO Dep.

When flowing gas issues into a chamber from an orifice or nozzle whose diameter is much smaller than that of the chamber, the resulting flow field constitutes a "free jet" bounded by relatively quiescent gas. If the pressure ratio across that nozzle or orifice exceeds a critical value (around 2.5 for most gases) the flow velocity will exceed the local speed of sound and the flow field is called a "supersonic free jet". Though somewhat exotic in name such supersonic jets are really quite common. What might be regarded as the modern era for analysis and application of supersonic free jets began in 1948 with a calculation by Owen and Thornhill who used the method of characteristics to solve Euler's equation for the flow field formed by the free expansion of gas from a sonic orifice into a region of zero pressure. Three years-later in another now-classic paper Kantrowitz and Grey proposed the use of a supersonic low density flow field as a source for molecular beams of high intensity. These two independent communications, motivated by entirely different interests and objectives, were destined to become related as the ancestors of a large progeny that form a flourishing family tree with many roots and branches. Some of the fruits of that tree are being served at this conference. They come from a branch that sprouted from the early experiments of E.W. Becker and his colleagues at the University of Marburg in 1954. These investigators were the first to achieve, by design, substantial success in reducing to practice the ideas set forth by Kantrowitz and Grey. However, in

the interests of historical accuracy it should be noted 27 years earlier, T.H. Johnson at Yale produced an intense molecular beam from a supersonic free jet of mercury vapor. Unfortunately, at that time his results were neither understood nor appreciated so he has not received the recognition and credit that he clearly deserves.

30213 (NREL/CP–433-7748, pp. 7-17) **Principles of free jets.** Miller, D.R. (Univ. of California, San Diego, La Jolla, CA (United States)). National Renewable Energy Lab., Golden, CO (United States). Mar 1995. (CONF-9410343–: Applications of free-jet, molecular beam, mass spectrometric sampling conference, Estes Park, CO (United States), 11-14 Oct 1994). In *Applications of free-jet, molecular beam, mass spectrometric sampling: Proceedings.* 305p. Order Number DE95004052. Source: OSTI; NTIS; GPO Dep.

The principles of the free jet expansion are well established and only a brief tutorial overview of selected concepts is presented below. Almost every important theoretical and/or experimental aspect of the free jet related to molecular beam sampling has appeared in one of the 19 International Symposium on Rarefied Gas Dynamics and many detailed reviews exist. The first stage of pressure reduction in a mass spectrometer sampling system is often simply an aperture or short capillary tube across which a significant pressure ratio is maintained. When this pressure ratio between the system being sampled and the first vacuum stage exceeds about two then the gas flow reaches sonic conditions at the exit, Mach number M = 1, and the exiting flow is known as "choked" flow. It is called choked because for fixed source conditions the mass flux out of the aperture will not exceed this M = 1 condition regardless of how low the exit chamber pressure is taken, ie how much pumping is added. Beyond the exit the gas expands in a supersonic free jet expansion as it adjusts to the low pressure in the exit chamber. The expansion is called a free jet because there are no diverging nozzle walls to constrain the flow, which would lead to viscous boundary layers and a much smaller rate of expansion. Diverging nozzle walls are used in rockets to direct the exiting flows along the axis for better forward thrust, and researchers use them to slow the rate of expansion to, for example, grow clusters or study fast kinetics. Only the free jet is dealt with here. The free jet nozzle only consists of the subsonic nozzle geometry. The nozzle exit to be referred to here is then just the aperture or capillary exit, and the free jet expansion is the unconstrained subsequent supersonic flow downstream of this nozzle exit.

30214 (NREL/CP–433-7748, pp. 18-32) **Composition distortion in MBMS sampling.** Knuth, E.L. (Univ. of California, Los Angeles, CA (United States)). National Renewable Energy Lab., Golden, CO (United States). Mar 1995. (CONF-9410343–: Applications of free-jet, molecular beam, mass spectrometric sampling conference, Estes Park, CO (United States), 11-14 Oct 1994). In *Applications of free-jet, molecular beam, mass spectrometric sampling: Proceedings.* 305p. Order Number DE95004052. Source: OSTI; NTIS; GPO Dep.

The focus in this review is on molecular-beam mass-spectrometer (MBMS) sampling systems, as opposed to microprobes. A typical MBMS sampling system consists of a sampling probe (usually conical), a skimmer (also usually conical), and a detection system (usually some form of mass spectrometer with signal averaging). Important advantages of MBMS sampling include (a) the characteristic time for the expansion in the free jet can be made very small in comparison with many chemical relaxation times and (b) the sample monitored by the detector comes essentially from near the centerline of the sampling probe, thereby minimizing interactions of the sample with the probe surface. Notwithstanding these advantages, experience has shown that care is required to either minimize or correct for composition distortions arising from the presence and operation of a MBMS sampling system. Most of the known origins of such composition distortions were discussed already in the review of MBMS sampling prepared by the author in 1972. The present review is an update of that prior review. Hence, as appropriate, the present review will sometimes simply reference the earlier review, sometimes modify that review, and sometimes supplement it with results obtained during the past two decades. Hence the relevant literature appearing since 1972 is emphasized. The origins of distortions are reviewed in approximately the order in which they are encountered by a sample as it is captured and processed. Hence, the main body of the review begins with the possibility of radical recombination at the external probe surface and ends with the possibility of species fragmentation during detection; a later section on miscellaneous origins begins with the possibility of condensation in the free jet and ends with the possibility of contaminating the time-averaged signal for a given sampling location by the stored time-averaged signal for the prior sampling location.

30215 (NREL/CP–433-7748, pp. 33-42) **MBMS sampling from highly heated gas mixtures (1000-3000 K) and weakly ionized RF plasmas (800-2800 K) or laser plasmas (5000-20,000 K).** Campargue, R. (Laboratoire des Jets Moleculaires, Gif-sur-Yvette (France)); Lebehot, A. National Renewable Energy Lab., Golden, CO (United States). Mar 1995. (CONF-9410343–: Applications of free-jet, molecular beam, mass spectrometric sampling conference, Estes Park, CO (United States), 11-14 Oct 1994). In *Applications of free-jet, molecular beam, mass spectrometric sampling: Proceedings.* 305p. Order Number DE95004052. Source: OSTI; NTIS; GPO Dep.

The properties of the free jet expansion and molecular beam skimming can be applied to the sampling of a wide variety of gaseous media, as those considered in this workshop: reactive systems, high temperature gases, flames, plasma flows, shock zone gases, laser ablation plumes, gas phase in CVD or in high temperature corrosion, etc. In the authors' laboratory, as well as in many molecular beam groups, the MBMS sampling is not generally made for analysing the gas stagnating in the nozzle, but for optimizing and using the beam source in research experiments. Nevertheless, this beam optimization has been of great interest to investigate and minimize the distortions through the interface used for MS sampling. They are due to the reality of the gas, the deviations from ideal free jet expansion, and the possible interactions along the MBMS sampling system, from the nozzle sampler to the quadrupole analyser. The first part of this paper is an historical review on the various distortions observed at Saclay in skimming, or in MBMS sampling from room temperature gases or gas mixtures. The second part deals with neutral energetic particles resulting either from the cluster generation in expansion or from the seeding and/or heating techniques. Finally the last part of the paper is devoted to recent developments in MBMS sampling of weakly ionized RF plasmas (800-2800 K) and laser sustained plasmas (5000-20000 K). The presentation is made with large reference to the authors' previous papers, especially their later review on jets and beams.

30216 (NREL/CP–433-7748, pp. 43-50) **Electron impact, hyperthermal surface ionization and fast GC-MS in supersonic molecular beams.** Amirav, A. (Tel-Aviv Univ., Tel Aviv (Israel)); Dagan, S. National Renewable Energy Lab., Golden, CO (United States). Mar 1995. (CONF-9410343–: Applications of free-jet, molecular beam, mass spectrometric sampling conference, Estes Park, CO (United States), 11-14 Oct 1994). In *Applications of free-jet, molecular beam, mass spectrometric sampling: Proceedings.* 305p. Order Number DE95004052. Source: OSTI; NTIS; GPO Dep.

Supersonic Molecular Beams (SMB) are characterized by unidirectional motion with controlled hyperthermal kinetic energy (0.1-30 eV), intramolecular vibrational super-cooling, mass focusing as in an ideal high load jet separator, very high flow rate (on the gas chromatography flow rate scale) up to 240 ml/min and sample inlet at atmospheric pressure. These features make SMB an ideal sample introduction method, enable a unique fast GC inlet and result in important implications to molecular ionization processes including electron impact (EI) and hyperthermal. surface ionization (HSI). The authors' research is aimed at exploring and exposing the benefits of SMB for analytical organic mass spectrometry. The experimental apparatus is shown and is described. A 50 cm long megabore capillary column connects the atmospheric pressure open inlet to a supersonic nozzle, and serves as an ultra fast GC short column. The authors demonstrate ultrafast GC-MS achieved with this 50 cm transfer line capillary. One of the main features of this unique GC is the carrier gas relatively high flow rate of up to 240 ml/min which is possible due to the flow rates involved with the supersonic beam interface. This ultrafast GC is extensively described. Alternatively, a conventional GC with a short (4 meter) column serves as a fast

GC inlet with intermediate GC resolution and unlimited choice of column length, ID and flow rate. Electron impact ionization in supersonic molecular beams is achieved using a Brink type open ion source operated with ~ 10-20 mA emission current. A background ion filtration method is applied, based on differences in the ion energy emerging from the hyperthermal molecular kinetic energy in the seeded SMB. Background ion filtration is achieved in the authors' VG-SXP-600 quadrupole through biasing of its exit lens and the cancellation of its internal ion energy ramping with mass.

30217 (NREL/CP–433-7748, pp. 57-64) **Comparison of on-line MS techniques for complex reactive systems.** Meuzelaar, H.L.C. (Univ. of Utah, Salt Lake City, UT (United States)). National Renewable Energy Lab., Golden, CO (United States). Mar 1995. (CONF-9410343–: Applications of free-jet, molecular beam, mass spectrometric sampling conference, Estes Park, CO (United States), 11-14 Oct 1994). In *Applications of free-jet, molecular beam, mass spectrometric sampling: Proceedings.* 305p. Order Number DE95004052. Source: OSTI; NTIS; GPO Dep.

Using mass spectrometry as an on-line analytical method for studying the mechanisms and kinetics of reaction processes requires detailed awareness of various reaction interaction transport zones between the point of reaction and the point of ionization. The following zones (regimes, regions) can be more or less clearly recognized in most on-line MS studies of reactions in complex solids: (1) intramolecular; (2) intermolecular; (3) intraparticle; (4) interparticle (bed); (5) reactor (headspace); (6) pressure reduction; and (7) ionization. In an ideal on-line system all products, intermediates and precursors of interest should reach the ionization region without selective losses, chemical degradation or incanted background contributions. In practice, various secondary reactions occur well past zone 2, often resulting in chemical degradation of target analytes. Furthermore, marked losses of low volatile and or highly polar compounds are likely to occur between reaction and ionization regions unless potential cold spots and or active surfaces are carefully eliminated. Finally, unwanted background contributions from residues of previous runs and or ubiquitous contaminants may originate anywhere between zones 5 and 7.

30218 (NREL/CP–433-7748, pp. 65-79) **The observation of very large species in MBMS experiments.** Greene, F.T. (Midwest Research Institute, Kansas City, MO (United States)). National Renewable Energy Lab., Golden, CO (United States). Mar 1995. Contract NASW-4371. (CONF-9410343–: Applications of free-jet, molecular beam, mass spectrometric sampling conference, Estes Park, CO (United States), 11-14 Oct 1994). In *Applications of free-jet, molecular beam, mass spectrometric sampling: Proceedings.* 305p. Order Number DE95004052. Source: OSTI; NTIS; GPO Dep.

A molecular beam mass spectrometric system is arguably as close to a universal analytical device as has presently been achieved. However, various studies at MRI over the past 25 years suggest that some very large molecular entities may not be detected using typical MBMS techniques. Failure to account for these species may result in significant errors. These species may also be of importance in understanding nucleation and other molecular phenomena. It is the purpose of this paper to review the evidence for the presence of the very large species.

30219 (NREL/CP–433-7748, pp. 86-91) **Mass spectrometer sampling of supercritical water-oxidation reactions.** Miller, D.R. (Univ. of California, San Diego, La Jolla, CA (United States)); Maharrey, S. National Renewable Energy Lab., Golden, CO (United States). Mar 1995. (CONF-9410343–: Applications of free-jet, molecular beam, mass spectrometric sampling conference, Estes Park, CO (United States), 11-14 Oct 1994). In *Applications of free-jet, molecular beam, mass spectrometric sampling: Proceedings.* 305p. Order Number DE95004052. Source: OSTI; NTIS; GPO Dep.

Supercritical water is a useful medium for oxidation of toxic hydrocarbons because under such conditions hydrocarbons and oxidizers are dissolved into a single phase, diffusivities are high, the combustion is complete, and it occurs at relatively low temperatures. There is a large literature on the thermodynamics, kinetics, and applications of supercritical water oxidation. Supercritical fluids have also been used as solvent carriers in chromatography and the interface of the column output to mass spectrometers has been investigated by many researchers. In the present investigation the authors seek to operate a micro-reactor in which supercritical water oxidation kinetics can be examined and for which the output flow can be injected directly into a mass spectrometer system. The motivation for this approach was the microjet burner utilized by Groeger and Fenn for combustion studies. Water is one of the more difficult supercritical solvents to interface with the mass spectrometer, compared with CO_2 for example, because the pressures and temperatures are of order 30MPa and 500°C, and because the large water throughput must be removed by the vacuum pumps. They have fabricated supercritical nozzles from both stainless steel and from quartz capillary tubing. Despite the fact that supercritical water can dissolve quartz in the ppm range they have been able to operate quartz capillary reactors and nozzles in excess of 20hrs without any measurable degradation in performance. Because these nozzles are much easier to fabricate, especially to diameters below 0.004cm, they have been recently using them exclusively. This variable nozzle diameter is important because it permits us to vary the range of residence times in the reactor. The converging nozzle length is less than two capillary diameters, so the flow time through the nozzle is very short compared with the residence time in the reactor.

30220 (NREL/CP–433-7748, pp. 159-165) **MBMS studies of gas-phase kinetics in diamond chemical vapor deposition.** Fox, C.A. (Stanford Univ., CA (United States)); McMaster, M.C.; Tung, D.M. National Renewable Energy Lab., Golden, CO (United States). Mar 1995. DOE Contract AC04-76DP00789. (CONF-9410343–: Applications of free-jet, molecular beam, mass spectrometric sampling conference, Estes Park, CO (United States), 11-14 Oct 1994). In *Applications of free-jet, molecular beam, mass spectrometric sampling: Proceedings.* 305p. Order Number DE95004052. Source: OSTI; NTIS; GPO Dep.

A molecular beam mass spectrometer system (MBMS) has been used to determine the near-surface gaseous composition involved in the low pressure chemical vapor deposition of diamond. With this system, radical and stable species can be detected with a sensitivity better than 10 ppm. Threshold ionization techniques have been employed to distinguish between radical species in the deposition environment from radical species generated by parent molecule cracking. An extensive calibration procedure was used to enable the quantitative determination of H-atom and CH_3 radical mole fractions. Using the MBMS system, the gaseous composition involved in LPCVD of diamond has been measured for a wide variety of deposition conditions, including hot-filament gas activation, microwave-plasma gas activation, and a variety of precursor feed mixtures (ex: CH_4/H_2, C_2H_2/H_2). For microwave-plasma activation (MPCVD), the radical concentrations (H-atom and CH_3 radicals) are independent of the identity of the precursor feed gas provided the input carbon mole fraction is constant. However, in hot-filament diamond deposition (HFCVD), the atomic hydrogen concentration decreased by an order of magnitude as the mole fraction of carbon in the precursor mixture is increased to .07; this sharp reduction has been attributed to filament poisoning of the catalytic tungsten surface via hydrocarbon deposition. Additionally, the authors find that the H-atom concentration is independent of the substrate temperature for both hot-filament and microwave plasma deposition; radial H-atom diffusion is invoked to explain this observation.

30221 (PNL–10772) **Chemical and radiation stability of SuperLig®644, resorcinol-formaldehyde, and CS-100 cesium ion exchange materials.** Brown, G.N. (and others); Adami, S.R.; Bray, L.A. Pacific Northwest Lab., Richland, WA (United States). Sep 1995. 30p. Sponsored by USDOE, Washington, DC (United States). DOE Contract AC06-76RL01830. Order Number DE96000819. Source: OSTI; NTIS; INIS; GPO Dep.

At the request of the Initial Pretreatment Module Project within Westinghouse Hanford Company, Pacific Northwest Laboratory (PNL) conducted this study for the Efficient Separations and Processing Crosscutting Program (ESP) under the task "Develop and Test Sorbents." The purpose of the study was to assess and compare the chemical and radiolytic stability of several cesium-selective ion exchange materials in simulated alkaline Hanford tank waste matrices. Pretreatment of nuclear process wastes to remove of cesium and other radionuclides by ion exchange was proposed previously as one method of minimizing the amount of high-level

radioactive waste at Hanford. In this study, PNL evaluated three cesium-selective materials SuperLig®644, resorcinol-formaldehyde (R-F), and CS-100 for chemical and radiation stability in 1 M NaOH and a simulated neutralized current acid waste (NCAW). The objective of the study is to investigate the stability of the newly produced SuperLig®644 under a variety of conditions in an attempt to simulate and predict the degradation process. The following specific conclusions and recommendations resulted from the study.

30222 (PSI–95-10) **A quantitative mechanistic description of Ni, Zn and Ca sorption on Na-Montmorillonite. Part I: Physico-chemical characterisation and titration measurements.** Baeyens, B. (Paul Scherrer Inst. (PSI), Villigen (Switzerland)); Bradbury, M.H. Paul Scherrer Inst. (PSI), Villigen (Switzerland). Jul 1995. 73p. Order Number DE96602466. Source: OSTI; NTIS; INIS.

The work presented in this report is primarily concerned with characterisation studies and titration measurements on conditioned Na-montmorillonite. The starting material, SWy-1 Na-montmorillonite (Crook County, Wyoming, USA), contains background metal impurities, soluble salts and sparingly soluble minerals which can influence titration and sorption measurements and thereby lead to difficulties in the interpretation of the data. A conditioning procedure is described which yielded a purified clay material in the homoionic sodium form with a particle size < 0.5 μm. This so-called conditioned Na-montmorillonite was thoroughly physico-chemically characterised before carrying out batch titration measurements on suspensions in 0.1 and 0.5 M Na ClO_4. The reasons for choosing a batch method, coupled with back titration of the supernatant solutions, instead of a continuous procedure, are fully discussed. Chemical analyses data for the supernatant solutions are presented in detail. The influence of background impurities, not removed by the conditioning, and cation exchange processes on the form of the titration curves were investigates. Net Na-montmorillonite titration curves at two different ionic strengths were derived which are considered to reflect only the acid/base behaviour of $\equiv$SOH type surface sites. The acid end point in the titration data was used to estimate an $\equiv$SOH site capacity of 0.08 moles per kg conditioned Na-montmorillonite. (author) 8 figs., 19 tabs., refs.

30223 (PSI–95-11) **A quantitative mechanistic description of Ni, Zn and Ca sorption on Na-Montmorillonite. Part II: Sorption measurements.** Baeyens, B. (Paul Scherrer Inst. (PSI), Villigen (Switzerland)); Bradbury, M.H. Paul Scherrer Inst. (PSI), Villigen (Switzerland). Jul 1995. 58p. Order Number DE96602467. Source: OSTI; NTIS; INIS.

The main focus of the experimental work presented here is the sorption behaviour of Ni on conditioned Na-montmorillonite. Ca and Zn were also studied as important background impurity cations which can, depending on the circumstances, be competitive for the available sorption sites. Distribution ratios were measured for all three radionuclides at trace concentrations as a function of pH over a range from 2 to 10.5 to produce so-called 'sorption edges'. In the cases of Ca and Ni such measurements were carried out as a function of the $NaClO_4$ background electrolyte concentration. From the form of the sorption edges it was deduced that two main mechanisms were controlling the uptake of radionuclides onto the solid; a pH independent component, identified as cation exchange, and a pH dependent process interpreted as surface complexation on $\equiv$SOH type sites. In addition to sorption edges, sorption isotherms were determined for Ni and Zn in solutions of 0.1 M $NaClO_4$ at several pH values. The non-linear sorption isotherms indicated that in addition to cation exchange, at least 2 different $\equiv$SOH sites were present in Na-montmorillonite contributing to the overall sorption. (author) 22 figs., 10 tabs., refs.

30224 (PSI–95-12) **A quantitative mechanistic description of Ni, Zn and Ca sorption on Na-Montmorillonite. Part III: Modelling.** Baeyens, B. (Paul Scherrer Inst. (PSI), Villigen (Switzerland)); Bradbury, M.H. Paul Scherrer Inst. (PSI), Villigen (Switzerland). Jul 1995. 88p. Order Number DE96602468. Source: OSTI; NTIS; INIS.

Titration and sorption measurements, carried out under a wide variety of conditions on Na-montmorillonite, were examined in terms of cation exchange and surface complexation mechanisms. A computer code called MINSORB was developed and used throughout this work. This code allowed the uptake of radionuclides by both mechanisms to be calculated simultaneously; also taking into account competitive reactions from other cations present. A stepwise iterative fitting/modelling procedure is described. For the case of Na-montmorillonite it is demonstrated that an electrostatic term in the surface complexation model is not required. A basic data set comprising of site capacities and protonation/deprotonation constants was defined, which was valid for all surface complexation sorption reactions. The main study was carried out with Ni, but impurity cations present in the system, particularly Zn, had to be examined in addition due to their competitive effects on Ni sorption. The surface complexation behaviour of Ni and Zn was investigated in detail to give intrinsic surface complexation constants on two of the $\equiv$SOH type sites included in the model. The sorption of Mg, Ca and Mn is also considered, though in less detail, and estimated surface complexation constants for these nuclides are presented. Cation exchange was included in all of the calculations. Measured selectivity coefficients for Ni-Na, Zn-Na and Ca-Na exchange reactions are given. The model, with the derived parameters, allowed all the data from titration measurements through sorption edges to sorption isotherms to be calculated. (author) 31 figs., 9 tabs., refs.

30225 (SAND–95-0961) **Modifications to the Finnigan MAT 271 mass spectrometer in the Inorganic Gas Analysis Lab.** Reber, S.D. (Sandia National Labs., Albuquerque, NM (United States). Gas Analysis Lab.); Cordes, G.T. Sandia National Labs., Albuquerque, NM (United States). Aug 1995. 12p. Sponsored by USDOE, Washington, DC (United States). DOE Contract AC04-94AL85000. Order Number DE96000057. Source: OSTI; NTIS; GPO Dep.

This document presents an overview of the modifications that were done to the Finnigan MAT 271 mass spectrometer used in the Dept. 1823 Inorganic Gas Analysis Lab. Among the alterations to the spectrometer were addition of a new computer, interfaces to the power supply, addition of a multimeter and introduction of a Graphical User Interface software system to run the instrument. The impact of these improvements is also discussed. The appendix details a generic procedure for operating the instrument.

30226 (SAND–95-8633C) **Two-color resonant four-wave mixing: A tool for double resonance spectroscopy.** Rohlfing, E.A. (Sandia National Labs., Livermore, CA (United States). Combustion Research Facility); Tobiason, J.D.; Dunlop, J.R.; Williams, S. Sandia National Labs., Livermore, CA (United States). [1995]. 15p. Sponsored by USDOE, Washington, DC (United States). DOE Contract AC04-94AL85000. (CONF-9507141–2: Laser techniques for state selected and state-to-state chemistry III, San Diego, CA (United States), 11-14 Jul 1995). Order Number DE95016389. Source: OSTI; NTIS; GPO Dep.

Two-color resonant four-wave mixing (RFWM) shows great promise in a variety of double-resonance applications in molecular spectroscopy and chemical dynamics. One such application is stimulated emission pumping (SEP), which is a powerful method of characterizing ground-state potential energy surfaces in regions of chemical interest. The authors use time-independent, diagrammatic perturbation theory to identify the resonant terms in the third-order nonlinear susceptibility for each possible scheme by which two-color RFWM can be used for double-resonance spectroscopy. After a spherical tensor analysis they arrive at a signal expression for two-color RFWM that separates the molecular properties from purely laboratory-frame factors. In addition, the spectral response for tuning the DUMP laser in RFWM-SEP is found to be a simple Lorentzian in free-jet experiments. The authors demonstrate the utility of RFWM-SEP and test their theoretical predictions in experiments on jet-cooled transient molecules. In experiments on C_3 they compare the two possible RFWM-SEP processes and show that one is particularly well-suited to the common situation in which the PUMP transition is strong but the DUMP transitions are weak. They obtain RFWM-SEP spectra of the formyl radical, HCO, that probe quasibound vibrational resonances lying above the low threshold for dissociation to H+CO. Varying the polarization of the input beams or PUMP rotational branch produces dramatic effects, in the relative intensities of rotational lines in the RFWM-SEP spectra of HCO; these effects are well-described by their theoretical

analysis. Finally, RFWM-SEP spectra of HCO resonances that are homogeneously broadened by dissociation confirm the predicted lineshape and give widths that are in good agreement with those determined via unsaturated fluorescence depletion SEP.

30227 (WHC-SD-CP-QAPP–016-Rev.1) **222-S Laboratory Quality Assurance Plan. Revision 1.** Meznarich, H.K. Westinghouse Hanford Co., Richland, WA (United States). 31 Jul 1995. 300p. Sponsored by USDOE, Washington, DC (United States). DOE Contract AC06-87RL10930. Order Number DE96001067. Source: OSTI; NTIS; INIS; GPO Dep.

This Quality Assurance Plan provides,quality assurance (QA) guidance, regulatory QA requirements (e.g., 10 CFR 830.120), and quality control (QC) specifications for analytical service. This document follows the U.S Department of Energy (DOE) issued Hanford Analytical Services Quality Assurance Plan (HASQAP). In addition, this document meets the objectives of the Quality Assurance Program provided in the WHC-CM-4-2, Section 2.1. Quality assurance elements required in the Guidelines and Specifications for Preparing Quality Assurance Program Plans (QAMS-004) and Interim Guidelines and Specifications for Preparing Quality Assurance Project Plans (QAMS-005) from the US Environmental Protection Agency (EPA) are covered throughout this document. A quality assurance index is provided in the Appendix A. This document also provides and/or identifies the procedural information that governs laboratory operations. The personnel of the 222-S Laboratory and the Standards Laboratory including managers, analysts, QA/QC staff, auditors, and support staff shall use this document as guidance and instructions for their operational and quality assurance activities. Other organizations that conduct activities described in this document for the 222-S Laboratory shall follow this QA/QC document.

30228 (WSRC-MS–95-0376) **Separation and Analysis of Actinides by Extraction Chromatography Coupled with Alpha Liquid Scintillation Spectrometry.** Cadieux, J.R.; Reboul, S.H. Westinghouse Savannah River Co., Aiken, SC (United States). 21 Sep 1995. 5p. Sponsored by USDOE, Washington, DC (United States). DOE Contract AC09-89SR18035. (CONF-9511133–1: Bioassay conference, Boston, MA (United States), 12-16 Nov 1995). Order Number DE96060013. Source: OSTI; NTIS; GPO Dep.

This work describes the development and testing of a new method for the separation and analysis of most actinides of interest in environmental samples. It combines simplified extraction chromatography using highly selective absorption resins to partition the individual actinides with the measurement of their alpha activities by liquid scintillation spectrometry. The liquid scintillation counting technique pioneered by McDowell proved useful in determination of alpha emitting radionuclide in a wide variety of matrices. Alpha emitters are chemically extracted into an organic phase which also contains the scintillation cocktail. Oxygen is purged from the solution to improve the energy resolution of the measurement and the counting sample is sealed in a small glass tube for assay. The Photon-Electron Rejecting Alpha Liquid Scintillation (PERALS™) Spectrometer provides high counting efficiency, low background, pulse shape discrimination for photon/electron/β particle rejection and moderate energy resolution in a compact package. Chemical extraction/liquid scintillation counting significantly reduces the extensive chemical purification and electroplating required for conventional alpha spectrometry with semiconductor detectors. PERALS™ analyses have been used routinely for quickly surveying suspect samples and determining the source of unknown alpha activities.

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Refer also to citation(s) 28590, 28591, 28594, 28595, 28605, 28619, 28620, 28621, 28622, 28623, 28624, 28625, 28628, 28636, 28655, 28690, 28769, 28851, 28852, 28983, 29376, 29802, 29804, 29855, 29919, 30166, 30168, 30253, 30256, 30592, 30607, 30608, 30609, 30610, 30611, 30612, 30613, 30787, 30876, 31108, 31109, 31116, 31120, 31320, 31321, 31323, 31324, 31393

30229 (CONF-951205–1) **Ion-association: Models and thermodynamics.** Mesmer, R.E.; Ho, P.C.; Holmes, H.F.; Palmer, D.A.; Simonson, J.M. Oak Ridge National Lab., TN (United States). [1995]. 13p. Sponsored by USDOE, Washington, DC (United States). DOE Contract AC05-84OR21400. From International chemical congress of Pacific Basin Societies; Honolulu, HI (United States); 17-22 Dec 1995. Order Number DE95013969. Source: OSTI; NTIS; GPO Dep.

Association reactions are an important class for probing ion-water and water-water interactions. A review of some earlier results led to a model of ion-association reactions discussed by Mesmer et al. in Activity Coefficients of Electrolyte Solutions in 1991. Additional results especially from electrical conductance studies on acids and salts will be discussed. There is mounting evidence consistent with the general observations regarding the temperature and pressure dependencies for thermodynamic quantities for association reactions seen earlier including the driving force, TΔS, that originates from the release of ion hydrate waters when pairing occurs. The density model for log K_A serves well as a simple representation of the strong variation with temperature and pressure seen for these reactions. The decrease in solvent structure with increasing temperature and the increasing range of the ion-dipole interactions for hydrated ions (with decreasing dielectric constant) are thought to be the principal factors accounting for the dramatic trends seen for the thermodynamic quantities. Some discussion will be given of the simplicity found for the T-P dependencies for δU_v and δC_v, the changes in internal energy and heat capacity on a constant volume basis.

30230 (DOE/OR/21400–T491) **A new method for measuring the dynamic surface tension of complex-mixture liquid drops.** Zhang, X.; Harris, M.T.; Basaran, O.A. Oak Ridge National Lab., TN (United States). 29 Jun 1994. 58p. Sponsored by USDOE, Washington, DC (United States). DOE Contract AC05-84OR21400. Order Number DE96000672. Source: OSTI; NTIS; GPO Dep.

A simple and accurate technique has been developed for measuring dynamic surface tension. The new technique is based on growing a drop at the end of a fine capillary into another immiscible fluid and can follow the changes in tension at a freshly formed interface during its entire period of evolution. When the relative importance of the surface tension force is large compared to gravitational and viscous forces, shapes of growing drops are sections of spheres and the difference in pressure between the interior and the exterior of the drop Δp is related to the surface tension σ and the radius of curvature R by the static Young-Laplace formula $\Delta p = 2\sigma/R$. In contrast to related work, the new technique can determine the surface tension of an interface with a surface age of a few to tens of milliseconds by measuring transient drop shapes and pressures in 1/6 to 1 millisecond. The capabilities of the new method are demonstrated by performing tension measurements on liquid systems that do not exhibit dynamic surface tension as well as ones that exhibit significant dynamic tension effects. Tension measurements made with surfactant-laden solutions show that variation of surface tension is nonmonotonic in time. In such systems, the dynamic behavior of surface tension is shown to depend upon both the rate of interfacial dilatation and that of surfactant transport. A maximum in the surface tension is attained when the lowering of the surfactant concentration on the drop interface due to its dilatation is balanced by the addition of fresh surfactant to the interface by convection and diffusion.

30231 (DOE/PC/92106–T10) **Charge distribution analysis of catalysts under simulated reaction conditions. Technical progress report: Tenth quarter, January 1–March 31, 1995.** Freund, F. Surface/Interface, Inc., Mountain View, CA (United States). [1995]. 7p. Sponsored by USDOE, Washington, DC (United States). DOE Contract AC22-92PC92106. Order Number DE96000921. Source: OSTI; NTIS; GPO Dep.

As pointed out in the Ninth Quarterly Technical Progress Report, the CDA instrument had to be rebuilt in its entirety, using a replacement weighing mechanism from Perkin-Elmer Corporation. In addition it was equipped with two 1,000 W infrared heaters. Following extensive tests with the new system using single crystal MgO calibration standards, the authors prepared a pressed pellet of the high surface area Iron Oxide Catalyst No. 7 from the available

powder and began its dielectric polarization and surface charges. The overall $F_{\Sigma}(T)$ behavior of this iron oxide catalyst under study is consistent with either an increased polarization of structural defects in the iron oxide grains or the appearance of mobile charge carriers which polarize in the applied electric field.

30232 (ETDE/CH-mf–95787322, pp. 83-87) **The use of stable isotopes in ecological research: tracking the nitrogen fluxes of airborne NO_2 in plants.** Siegwolf, R. (Paul Scherrer Inst. (PSI), Villigen (Switzerland)); Saurer, M.; Matyssek, R.; Bucher, J.B. Paul Scherrer Inst. (PSI), Villigen (Switzerland). 1995. In *Paul Scherrer Institut annual report 1994. Annex V: PSI general energy technology newsletter 1994.* 123p. Source: OSTI; NTIS.

The use of stable isotopes in ecosystems analysis and plant physiology is of increasingly great interest in relationship to element and nutrient conditions. In the form of different compounds, the stable isotopes ^{13}C, ^{15}N, ^{18}O, $^{2}H(D)$, ^{34}S are incorporated by the vegetation, where they are processed differently than the lighter, more abundant isotopes ^{12}C, ^{14}N, ^{16}O, ^{1}H, ^{32}S. This leads to isotope ratio variations in plant tissue. Based on plant ecological studies and isotope analyses with the mass spectrometer at PSI (described here in detail), an example of the use of stable isotope analysis in ecological research and its advantages is discussed. By means of the ^{15}N isotope it could be demonstrated that plant leaves absorb NO_2 and incorporate it metabolically. Changes in physiological processes caused by NO_2 were also manifested in the $^{13}C/^{12}C$ ratio of the plant tissue. (author) 3 figs., 1 tab., 14 refs.

30233 (INIS-mf–14585) **Sorption of Fe^{3+}, Co^{2+}, Ce^{3+}, Cs^{+} and Ba^{2+} in zeolite X.** Martinez M, V. Universidad Autonoma Metropolitana, Mexico City (Mexico). Div. de Ciencias Basicas y Ingenieria. 1994. 56p. (In Spanish). Order Number DE96602478. Source: OSTI; NTIS (US Sales Only); INIS.

The sorption behavior of Fe^{3+}, Co^{2+}, Ce^{3+}, Cs^{+}, and Ba^{2+} in aqueous solutions, was studied in presence of zeolite X. Solutions of $Fe(NO_3)_3 \cdot 9\ H_2O$, $Co(NO_3)_2 \cdot 6\ H_2O$, $Ce(NO_3)_3 \cdot 6\ H_2O$, $CsNO_3$ and $Ba(NO_3)_2$ were labelled with the respectively radioactive isotopes Fe^{59}, Co^{60}, Cs^{134}, Ba^{139} and Ce^{141}. 20 ml. of each solution was left in contact with 200 mg. of zeolite for different periods. Later the zeolites were separated by centrifugation from the aqueous solutions and the radioactivity of the aqueous phases was measured with a NaI(Tl) solid-state well detector coupled to a single-channel Picker analyzer or with a Gel hyper pure solid-state detector coupled to a 2048 channel pulse height analyzer. When Cs^{+} in the aqueous solutions was left in contact with zeolite X it was found that it does not occupy all cationic sites in the zeolite due to the ionic radium effect. A similar behavior was found for the divalent ions. In all cases, when the pH was not controlled, the zeolite lost part of its crystallinity and when the divalent ions were exchanged again by Na^{+}, the zeolite recovered completely its crystallinity. During the sorption, the ionic radius, and the charge are important parameters as well as the pH. When the pH of the solution was adjusted between 6.5 - 7.0 the crystallinity was maintained in some cases. For Fe^{3+} the crystallinity after the ion exchange was 94 % and when the pH was not adjusted the crystallinity was completely lost. It was found as well that the zeolite X induces the formation of H_3O^{+} which competes with the cations for the sites in the zeolite. (Author).

30234 (INIS-mf–14590) **Synthesis and characterization of tetraphenylporphyrinate of dysprosium route dysprosium acetylacetonate.** Martinez M, V. Universidad Autonoma del Estado de Mexico, Toluca (Mexico). Facultad de Quimica. 1992. 108p. (In Spanish). Order Number DE96602472. Source: OSTI; NTIS (US Sales Only); INIS.

Dysprosium bis (tetraphenylporphyrinate) and bis (dysprosium) Tris (tetraphenylporphyrinate) were synthesized from dysprosium tetraphenylporphyrinate prepared in situ, and characterized by IR, UV-vis, TGA, DTA, EPR and magnetic susceptibility measurements. The double decker compound was obtained by direct oxidation of the $HDy(TPP)_2$ intermediate. The existence of the radical anion, $(TPP)^{-}$, in the double decker product was conformed by EPR spectrometry. Dysprosium monoporphyrinate was isolated and characterized by the same techniques. (Author).

30235 (KAERI-NEMAC/RR–113/94) **Long-term integrity study on storage facility of spent fuel/Improvement of cooling water purification technology in a spent fuel storage pool.** Ro, Seung Gy (Korea Atomic Energy Research Institute, Taejon (Korea, Republic of)); Shin, Young Joon; Cho, Soo Heang; Chung, Dong Yong; Rim, Jae Kwan; Lee, Won Kyung. Korea Atomic Energy Research Inst., Taejon (Korea, Republic of). Dec 1994. 104p. (In Korean). Order Number DE95778398. Source: OSTI; NTIS (US Sales Only).

The important design factors of an ion-exchange column are the selection of proper ion-exchanger, the hydro-dynamic behavior of the column such as pressure drop and mass transfer, and the position of cooling water in-let point. In this study, the analysis method of design factors was systematically introduced and some engineering equations and data were collected. On the experiment for the evaluation of ion-exchange capability, the effects of irradiation dose and temperature on the ion-exchange capability of each ion-exchanger were observed and the ion-exchange rate and ion-selectivity of each ion-exchanger in a multi-component cooling water system were also measured.

30236 (K/ETO–140-Rev.1) **A spreadsheet-coupled SOLGAS: A computerized thermodynamic equilibrium calculation tool. Revision 1.** Trowbridge, L.D. (Oak Ridge K-25 Site, TN (United States). Technical Analysis and Operations Div.); Leitnaker, J.M. Oak Ridge K-25 Site, TN (United States). Jul 1995. 120p. Sponsored by USDOE, Washington, DC (United States). DOE Contract AC05-84OT21400. Order Number DE95017843. Source: OSTI; NTIS; INIS; GPO Dep.

SOLGAS, an early computer program for calculating equilibrium in a chemical system, has been made more user-friendly, and several "bells and whistles" have been added. The necessity to include elemental species has been eliminated. The input of large numbers of starting conditions has been automated. A revised spreadsheet-based format for entering data, including non-ideal binary and ternary mixtures, simplifies and reduces chances for error. Calculational errors by SOLGAS are flagged, and several programming errors are corrected. Auxiliary programs are available to assemble and partially automate plotting of large amounts of data. Thermodynamic input data can be changed on line. The program can be operated with or without a co-processor. Copies of the program, suitable for the IBM-PC or compatibles with at least 384 bytes of low RAM, are available from the authors. This user manual contains appendices with examples of the use of SOLGAS. These range from elementary examples, such as, the relationships among water, ice, and water vapor, to more complex systems: phase diagram calculation of UF_4 and UF_6 system; burning UF_4 in fluorine; thermodynamic calculation of the Cl-F-O-H system; equilibria calculations in the CCl_4–CH_3OH system; and limitations applicable to aqueous solutions. An appendix also contains the source code.

30237 (LA-UR–95-1975) **A molecular architectural approach to second-order nonlinear optical materials.** Yang, Xiaoguang; McBranch, D.; Swanson, B.; Li, DeQuan. Los Alamos National Lab., NM (United States). [1995]. 8p. Sponsored by USDOE, Washington, DC (United States). DOE Contract W-7405-ENG-36. (CONF-950412–55: Spring meeting of the Materials Research Society (MRS), San Francisco, CA (United States), 17-21 Apr 1995). Order Number DE95017851. Source: OSTI; NTIS; GPO Dep.

Design and synthesis of a family of calix[4]arene-based nonlinear optical (NLO) chromophores are discussed. The calixarene chromophores are macrocyclic compounds consisting These molecules were synthesized such of four simple D-π-A units bridged by methylene groups. These molecules were synthesized such that four D-n-A units of the calix[4]arene were aligned along the same direction with the calixarene in a cone conformation. These nonlinear optical super-chromophores were subsequently fabricated into covalently bound self-assembled monolayers on the surfaces of fused silica and silicon. Spectroscopic second harmonic generation (SHG) measurements were carried out to determine the absolute value of the dominant element of the nonlinear susceptibility, X_{zzz}, and the average molecular alignment, Ψ. We find a value of $X_{zzz} \sim 1.5 \times 10^{-7}$ esu (60 pm/V) at a wavelength of 890 nm, and $\Psi \sim 36°$ with respect to the surface normal.

30238 (LBL–36875) **Defect studies with isotopically designed semiconductors.** Haller, E.E. (Lawrence Berkeley Lab., CA (United States). Materials Sciences Div.). Lawrence Berkeley Lab., CA (United States). Jul 1995. 5p. Sponsored by USDOE, Washington, DC (United States);National Science Foundation, Washington, DC (United States). DOE Contract AC03-76SF00098. Grant DMR-94 17763. (CONF-9507172–1: 18. international conference on defects in semiconductors, Sendai (Japan), 23-28 Jul 1995). Order Number DE96000126. Source: OSTI; NTIS; INIS; GPO Dep.

Most semiconductors consist of elements which are made up of a number of stable isotopes. Access to highly enriched isotopes in macroscopic quantities opens up new and unique possibilities for semiconductor defect research. The use of isotope mass sensitive effects including the frequencies of local vibrational modes, nuclear spin, as well as nuclear cross sections for thermal neutron capture for the study of native and impurity defects will be reviewed and illustrated with relevant examples. First, the extreme simplification of the local vibrational mode (LVM) spectrum of oxygen in Ge obtained through isotopic control of the Ge host lattice will be reviewed with emphasis on the spectral features which became accessible through this simplification. Second, self and impurity diffusion studies with isotopically designed multilayer structures will be discussed. Third, the authors will discuss defect and dopant investigations based on the neutron transmutation doping (NTD) technique.

30239 (LBL–37533) **Bis(pentamethylcyclopentadienyl)ytterbium: An investigation of weak interactions in solution using multinuclear NMR spectroscopy.** Schwartz, D.J. Lawrence Berkeley Lab., CA (United States). Jul 1995. 200p. Sponsored by USDOE, Washington, DC (United States). DOE Contract AC03-76SF00098. Order Number DE96001060. Source: OSTI; NTIS; GPO Dep.

NMR spectroscopy is ideal for studying weak interactions (formation enthalpy $\leq$20 kcal/mol) in solution. The metallocene bis(pentamethylcyclopentadienyl)ytterbium, Cp^*_2Yb, is ideal for this purpose. cis-P_2PtH_2complexes (P = phosphine) were used to produce slow-exchange Cp^*_2YbL adducts for NMR study. Reversible formation of $(P_2PtH)_2$ complexes from cis-P_2PtH_2 complexes were also studied, followed by interactions of Cp^*_2Yb with phosphines, R_3PX complexes. A NMR study was done on the interactions of Cp^*_2Yb with H_2, CH_4, Xe, CO, silanes, stannanes, C_6H_6, and toluene.

30240 (LBL–37646) **Trivalent metallocene chemistry of some uranium, titanium, and zirconium complexes.** Lukens, W.W. Jr. Lawrence Berkeley Lab., CA (United States). May 1995. 307p. Sponsored by USDOE, Washington, DC (United States);National Science Foundation, Washington, DC (United States). DOE Contract AC03-76SF00098. Order Number DE96001061. Source: OSTI; NTIS; INIS; GPO Dep.

Dicyclopentadienyluranium halide dimers have been prepared and their solution behavior examined. These molecules exist as dimers in solution, and the halide ligands undergo rapid site exchange on the NMR timescale above 50 C. Analogous dicyclopentadienyluranium hydroxide dimers have also been prepared; they oxidatively eliminate hydrogen to give the corresponding oxide dimers. Mechanism of this reaction is consistent with αmigration of one of the hydroxide hydrogen atoms to a uranium center followed by elimination of hydrogen. Ground state of $[(Me_3Si)_2C_5H_3]_3M$ M = Nd, U and their base adducts has been examined by variable temperature magnetic susceptibility and EPR spectroscopy. The ground state is found to be $^4I_{9/2}$ with a crystal field state consisting largely of J_z = 1/2 lowest, in agreement with previous studies on triscyclopentadienylneodymium complexes. The zirconium metallocene Cp_3Zr has been prepared, characterized crystallographically, and its reactivity studied. Its chemical behavior is controlled by presence of an electron in the non-bonding, d_z2 orbital which prevents formation of base adducts Of Cp_3Zr, but allows Cp_3Zr to abstract atoms from other molecules. Electonic and EPR spectra of Cp^*_2TiX complexes, where Cp^* is Me_5C_5 and X is a monodentate, anionic ligand such as halide, have been studied. A π-bonding spectrochemical series is developed, and trends in π-bonding ability are found similar to those in other inorganic complexes. The β-agostic interactions in $Cp^*_2TiN(Me)Ph$ have been examined using variable temperature EPR spectroscopy, and the enthalpy/entropy of the interaction determined. In Cp^*_2TiEt, enthalpy of the β-agostic interaction is –1.9 kcal/mol. The titanocene anion, $Cp^*_2TiLi(TMEDA)$ (TMEDA is N,N,N',N'-tetramethylethylenediamine), has been prepared and its structure determined.

30241 (MLM–63) **Production research progress report, February 16–29, 1948.** Payne, J.H. Jr. Monsanto Chemical Co., Dayton, OH (United States). [1948]. 13p. Sponsored by USDOE, Washington, DC (United States). DOE Contract AC24-88DP43495. Order Number DE96001490. Source: OSTI; NTIS; GPO Dep.

The equipment for the Bismuth-II process has been installed at Unit IV., and two runs have been made. The results on the potential of bismuth in bismuth chloride solutions have been summarized and calculations made on the concentration of silver in solution which must be present if silver is to be reduced to the metal by Metallic bismuth. The results have been compared with earlier experiments in which the deposition of silver on bismuth was investigated by the use of gamma active silver as a tracer. From the results it becomes quite evident that the scrubbing of silver on bismuth, under the present conditions employed in the production process, cannot be attributed to the reduction of silver to the metal, but must result from the adsorption of silver ions on the surface of the bismuth powder. From these same calculations it is also evident that when silver is employed as a scrubbing medium, bismuth will be deposited on the silver surface until the silver concentration in the bismuth chloride solution reaches a concentration of 20–200 ppM of silver in the bismuth, depending on the chloride concentration of the solution.

30242 (MLM–175) **Gamma scale chemistry progress report, August 1–31, 1948.** Martin, A.W. Mound Lab., Miamisburg, OH (United States). [1948]. 13p. Sponsored by USDOE, Washington, DC (United States). DOE Contract AC04-76DP00053. Order Number DE96001430. Source: OSTI; NTIS; GPO Dep.

Attempts for preparation and x-ray diffraction studies of postum (polonium 210) bromide and dioxide are described. Surrogate parallel studies employing parallel compounds of tellurium and thorium are also related.

30243 (NEI-NO–575) **Extraction of quantitative information in gas chromatographic - mass spectral data by latent variable projections.** Brakstad, F. Bergen Univ. (Norway). Aug 1994. 152p. Order Number DE96703732. Source: OSTI; NTIS.

This doctoral thesis begins with a brief introduction to gas chromatography - mass spectrometry (GC-MS) and multivariate analysis, and proceeds with a description of the general strategy for using experimental design and latent variables to extract relevant quantitative information from complex systems. The thesis includes five published papers. Paper I discusses preprocessing of analytical profiles in the presence of homoscedastic or heteroscedastic noise. Paper II treats the combined use of principal component analysis and partial least squares regression to the interpretation of polychlorinated dibenzofuran (PCDF) and dibenzo-p-dioxin (PCDD) patterns in crabs. A strategy for building multivariate models capable of predicting changes in community structure from environmental data is presented in Paper III. In Paper IV an objective approach is given for selecting the most significant fragments for mass spectrum-structure correlation, and Paper V describes a method for resolution of two-way data. 291 refs., 51 figs., 15 tabs.

30244 (SAND–94-1949) **Estimating the hydrogen ion concentration in concentrated NaCl and Na_2SO_4 electrolytes.** Rai, D. (Pacific Northwest Lab., Richland, WA (United States)); Felmy, A.R.; Juracich, S.P.; Rao, F. Sandia National Labs., Albuquerque, NM (United States); Pacific Northwest Lab., Richland, WA (United States). Jun 1995. 81p. Sponsored by USDOE, Washington, DC (United States). DOE Contract AC04-94AL85000. Order Number DE95016459. Source: OSTI; NTIS; GPO Dep.

Combination glass electrodes were tested for determining H^+ concentrations in concentrated pure and mixed NaCl and Na_2SO_4 solutions, as well as natural brine systems. NaCl, Na_2SO_4, and mixtures of NaCl and Na_2SO_4 solutions were analyzed. Correction factors for estimating pC_{H^+} (negative logarithm of H^+ concentration) were determined from measured/observed pH values. Required Gran-type titrations were done with HCl and/or NaOH. The titration method is described and a step-by-step procedure

provided; it has been used previously for determining pC_H^+ values of synthetic chloride-dominated brines. Precautions are required to determine correction factors for electrolytes that react with H^+ or OH^- [sulfate brines for titration with acid; magnesium brines for titration with base because of precipitation of Mg(OH)2]. Correction factors A ($pC_H^+ = pH_{ob} + A$) from HCl titrations were similar to those from NaOH titrations where the concentration of free H^+ was calculated using a thermodynamic model. These values should be applicable to solns with a very large range in measured pH values (2 to 12). Because a large number of solns were titrated with HCl and the A values are similar for HCl and NaOH titrations, the A values for NaCl and Na2SO4 solns were fit as a function of molality to allow extrapolation. For NaCl solns 0 to 6.0 M, A can be obtained by multiplying the molality by 0.159. For Na2SO4 solns 0 to 2.0 M, the values of A can be obtained from ($0.221 - 0.549X + 0.201X^2$), where X is the molality of Na_2SO_4. Orion-Ross electrode evaluations indicated that the A values did not differ significantly for different electrodes. Results suggest that the data in this report can be used to estimate A values for different NaCl and Na_2SO_4 solns even for noncalibrated electrodes.

4004 Electrochemistry

Refer also to citation(s) 28587, 28983, 29161, 29808, 30192, 30201

30245 (IS-T–1739) **Synthesis, characterization and application of electrode materials.** He, L. Ames Lab., IA (United States). 7 Jul 1995. 161p. Sponsored by USDOE, Washington, DC (United States). DOE Contract W-7405-ENG-82. Order Number DE96000218. Source: OSTI; NTIS; GPO Dep.

It has been known that significant advances in electrochemistry really depend on improvements in the sensitivity, selectivity, convenience, and/or economy of working electrodes, especially through the development of new working electrode materials. The advancement of solid state chemistry and materials science makes it possible to provide the materials which may be required as satisfactory electrode materials. The combination of solid state techniques with electrochemistry expands the applications of solid state materials and leads to the improvement of electrocatalysis. The study of Ru-Ti_4O_7 and Pt-Ti_4O_7 microelectrode arrays as introduced in paper 1 and paper 4, respectively, focuses on their synthesis and characterization. The synthesis is described by high temperature techniques for Ru or Pt microelectrode arrays within a conductive Ti_4O_7 ceramic matrix. The characterization is based on the data obtained by x-ray diffractometry, scanning electron microscopy, voltammetry and amperometry. These microelectrode arrays show significant enhancement in current densities in comparison to solid Ru and Pt electrodes. Electrocatalysis at pyrochlore oxide $Bi_2Ru_2O_{7.3}$ and $Bi_2Ir_2O_7$ electrodes are described in paper 2 and paper 3, respectively. Details are reported for the synthesis and characterization of composite $Bi_2Ru_2O_{7.3}$ electrodes. Voltammetric data are examined for evidence that oxidation can occur with transfer of oxygen to the oxidation products in the potential region corresponding to anodic discharge of H_2O with simultaneous evolution of O_2. Paper 3 includes electrocatalytic activities of composite $Bi_2Ir_2O_7$ disk electrodes for the oxidation of I^- and the reduction of IO_3^-.

30246 (MLM–26) **Monsanto Chemical Company, Unit 3 progress report, January 16–31, 1948.** Monsanto Chemical Co., Dayton, OH (United States). [1948]. 4p. Sponsored by USDOE, Washington, DC (United States). DOE Contract AC24-88DP43495. Order Number DE96001500. Source: OSTI; NTIS; GPO Dep.

Solubilities – Orban: The solubility of postum in various concentrations of nitric acid was determined at 25.4°C. Hydrofluoric and Trifluoroacetic Acids – Abel and Raiff: Details of this work will be reported in the next Progress Report. Conversion of Nitric Acid Solutions to Hydrofluoric Acid Solutions – Bell: Conversion of production solutions to hydrofluoric acid solutions was tried by precipitation with ammonium oxalate, aluminum hydroxide, ammonium hydroxide, and sodium carbonate. Silver and Teflon discs were used.

30247 (MLM–75) **Electrodeposition research progress report, March 1–31, 1948.** Orban, E. Monsanto Chemical Co., Dayton, OH (United States). [1948]. 15p. Sponsored by USDOE, Washington, DC (United States). DOE Contract AC24-88DP43495. Order Number DE96001494. Source: OSTI; NTIS; GPO Dep.

Plating of Postum out of Nitric Acid and Hydrofluoric Acid Solutions – W. Abel and W. Raiff. Postum was plated out of 1.5 normal nitric acid and 1.0 normal hydrofluoric acid under similar conditions. The hydrofluoric acid plate was better appearing, and had a much higher curie density. However, neutron counts in these runs were quite similar. Neutron Counts – W. Abel and W. Raiff. A study of the change of neutron counts over a period of time was started. Conversion of Active Hydrofluoric Acid Solutions to Hydrochloric Acid Solutions – W. Raiff. A 99.99+ per cent conversion was effected. Conversion of Production Solutions to 1.0 Normal Hydrofluoric Add Solutions – R. Bell. Good conversion has been achieved; however, further work needs to be done on complete change of postum from the production solution to 1.0 normal hydrofluoric acid solutions.

30248 (MLM–168) **Production electrolysis studies V.** Power, W.H.; Ford, M. Mound Lab., Miamisburg, OH (United States). [1948]. 6p. Sponsored by USDOE, Washington, DC (United States). DOE Contract AC04-76DP00053. Order Number DE96001425. Source: OSTI; NTIS; GPO Dep.

This study seeks to determine the decomposition of bismuth trioxide by polarography. Results gained confirmed that at decomposition potentials observed that bismuth will not be reduced under normal plating conditions observed during production.

4005 Photochemistry

Refer also to citation(s) 30272, 31104, 31108

30249 (ETDE/CH-mf–95787322, pp. 43-46) **Luminescence and photoconversion of solar energy.** Schubnell, M. (Paul Scherrer Inst. (PSI), Villigen (Switzerland)); Kamber, I.; Forss, L. Paul Scherrer Inst. (PSI), Villigen (Switzerland). 1995. In *Paul Scherrer Institut annual report 1994. Annex V: PSI general energy technology newsletter 1994*. 123p. Source: OSTI; NTIS.

The temperature dependence of the luminescence of TiO_2 and ZnO is measured in vacuum in the temperature range between 20°C and 800°C. The results indicate, that different quenching mechanisms may be important to understand the observed luminescence. We further show that the luminescence is affected by the presence of methane and hydrogen. We propose luminescence measurements under various gaseous atmospheres in combination with highly sensitive species detection such as infrared spectroscopy as a valuable tool to clarify luminescence quenching mechanisms. (author) 5 figs., 10 refs.

30250 (LBL–37540) **Photofragment translational spectroscopy of three body dissociations and free radicals.** North, S.W. Lawrence Berkeley Lab., CA (United States). Apr 1995. 235p. Sponsored by USDOE, Washington, DC (United States). DOE Contract AC03-76SF00098. Order Number DE96000114. Source: OSTI; NTIS; GPO Dep.

This dissertation describes several three-body dissociations and the photodissociation of methyl radicals studied using photofragment translational spectroscopy. The first chapter provides an introduction to three body dissociation, examines current experimental methodology, and includes a discussion on the treatment of photofragment translational spectroscopy data arising from three-body fragmentation. The ultraviolet photodissociation of azomethane into two methyl radicals and nitrogen is discussed in chapter 2. Chapter 3 describes the photodissociation of acetone at 248 nm and 193 nm. At 248 nm the translational energy release from the initial C-C bond cleavage matches the exit barrier height and a comparison with results at 266 nm suggests that $\langle E_T \rangle$ is invariant to the available energy. A fraction of the nascent CH_3CO radicals spontaneously dissociate following rotational averaging. The $\langle E_T \rangle$ for the second C-C bond cleavage also matches the exit barrier height. At 193 nm the experimental data can be successfully fit assuming that the dynamics are analogous to those at 248 nm. A simplified model of energy partitioning which adequately describes the experimental results is discussed. Experiments on acetyl halides provide additional evidence to support the proposed acetone dissociation mechanism. A value of 17.0±1.0 kcal/mole for

the barrier height, CH_3CO decomposition has been determined. The photodissociation of methyl radical at 193 nm and 212.8 nm is discussed in the chapter 5. The formation of CH_2 ($^1A_1$) and H (^2S) was the only single photon dissociation pathway observed at both wavelengths.

4006 Radiation Chemistry

Refer also to citation(s) 30024

30251 (INIS-mf–14595) **Photochemical decomposition of Formaldehyde in solution.** Garrido Z, G. Universidad Autonoma del Estado de Mexico, Toluca (Mexico). Facultad de Quimica. 1995. 53p. (In Spanish). Order Number DE96602531. Source: OSTI; NTIS (US Sales Only); INIS.

In this work was studied the effect of ultraviolet radiation produced by a mercury low pressure lamp in solutions of formaldehyde. These solutions were exposed to ultraviolet rays at different times. In some of these series of solutions was added a photosensibilizer in order to obtain a high photodecomposition of formaldehyde. The techniques used for determine the products of the decomposition were the following: 1. In order to measure the residual formaldehyde and glioxal, the Hantzsch and 2,4-dinitrophenylhydrazine methods were used. 2. pH's measurements of the solutions, before and after exposition. 3. Paper's chromatography for determine presence of formed acids. 4. Acid-base tritiations for measure total acidification. We observed that when the time of exposition to UV rays was increased, a high photodecomposition of formaldehyde was formed and, besides, a greater quantity of another products. Of the reagents used like photosensibilizers, with the ruthenium reagent, the best results were obtained. (Author).

30252 (UM-P–95/14) **Focussed ion beam lithography using a MeV proton beam microprobe for microoptics fabrication.** Mason, L.M.; Roberts, A.; Jamieson, D.N.; Saint, A. Melbourne Univ., Parkville, VIC (Australia). School of Physics. 1995. 15p. Sponsored by Australian Research Council, Canberra, ACT (Australia). Order Number DE96602532. Source: OSTI; NTIS; INIS.

Deep, high-aspect ratio trenches have been fabricated in the resist polymethyl methacrylate by exposure to a focussed beam of MeV protons followed by development. The depth of the trenches depends on the energy of the protons and simulations suggest that this can be up to 300 μm. The University of Melbourne Microprobe is capable of producing a focussed spot size of the order of a few microns. This opens up the possibility of fabrication extremely high-aspect ratio microstructures for use as optical components. 9 refs., 3 figs.

4007 Radiochemistry and Nuclear Chemistry

Refer also to citation(s) 28767, 28811, 28857, 29161, 29176, 30211, 30236, 30242, 30248, 30482, 31390

30253 (MLM–103) **Density of metallic polonium.** Brody, B. Mound Lab., Miamisburg, OH (United States). 18 May 1948. 16p. Sponsored by USDOE, Washington, DC (United States). DOE Contract AC04-76DP00053. Order Number DE96001403. Source: OSTI; NTIS; GPO Dep.

Determinations of the density and coefficient of thermal expansions of postum (Polonium 210) were attempted on 20 curies of polonium as obtained from production foils.

30254 (MLM–113) **Physics group progress report, May 1–31, 1948.** Knauss, H.P. Mound Lab., Miamisburg, OH (United States). [1948]. 12p. Sponsored by USDOE, Washington, DC (United States). DOE Contract AC04-76DP00053. Order Number DE96001405. Source: OSTI; NTIS; GPO Dep.

Various studies conducted at Mound Laboratory concerning physical properties of postum (Polonium 210) are described. Some studies are entitled Purity of Postum (Vacuum Balance Method); Vapor Pressure of Postum; X-ray Studies; Vapor Pressure by Effusion; Molecular Weigh of Postum; and Weighing Procedures for Macroassay.

30255 (MLM–114) **General chemistry progress report, May 1–31, 1948.** Power, W.H. Mound Lab., Miamisburg, OH (United States). [1948]. 8p. Sponsored by USDOE, Washington, DC (United States). DOE Contract AC04-76DP00053. Order Number DE96001406. Source: OSTI; NTIS; GPO Dep.

Three studies are described: diffusion of postum (Polonium 210), measurement of standard potential of postum, and polarography with the cathode controller.

30256 (MLM–158) **Physics group progress report, July 1–31, 1948.** Knauss, H.P. Mound Lab., Miamisburg, OH (United States). [1948]. 6p. Sponsored by USDOE, Washington, DC (United States). DOE Contract AC04-76DP00053. Order Number DE96001424. Source: OSTI; NTIS; GPO Dep.

Preparatory work is described for the determination of the vapor pressure of postum (Polonium 210), selenium being used as a surrogate in construction and testing of the apparatus to measure vapor pressure. Design modifications of a vacuum balance are also described.

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Refer also to citation(s) 29268, 29313, 29944, 29945, 29967, 30131, 30215, 30315, 30349, 31320, 31321

30257 (LA-UR–95-2369) **Shock compression of liquid hydrazine.** Garcia, B.O. (Los Alamos National Lab., NM (United States)); Chavez, D.J. Los Alamos National Lab., NM (United States). [1995]. 9p. Sponsored by National Aeronautics and Space Administration, Washington, DC (United States). (CONF-950846–8: American Physical Society biennial conference on shock compression of condensed matter, Seattle, WA (United States), 13-18 Aug 1995). Order Number DE95016826. Source: OSTI; NTIS; GPO Dep.

Liquid hydrazine (N_2H_4) is a propellant used by the Air Force and NASA for aerospace propulsion and power systems. Because the propellant modules that contain the hydrazine can be subject to debris impacts during their use, the shock states that can occur in the hydrazine need to be characterized to safely predict its response. Several shock compression experiments have been conducted in an attempt to investigate the detonability of liquid hydrazine; however, the experiments results disagree. Therefore, in this study, we reproduced each experiment numerically to evaluate in detail the shock wave profiles generated in the liquid hydrazine. This paper presents the results of each numerical simulation and compares the results to those obtained in experiment. We also present the methodology of our approach, which includes chemical kinetic experiments, chemical equilibrium calculations, and characterization of the equation of state of liquid hydrazine.

30258 (NREL/CP–433-7748, pp. 51-56) **MBMS and gas phase chromatography studies of n-heptane and iso-octane flames.** Vovelle, C. (Laboratoire de Combustion et Systemes Reactifs, Orleans (France)); Doute, C.; Delfau, J.L. National Renewable Energy Lab., Golden, CO (United States). Mar 1995. (CONF-9410343–: Applications of free-jet, molecular beam, mass spectrometric sampling conference, Estes Park, CO (United States), 11-14 Oct 1994). In *Applications of free-jet, molecular beam, mass spectrometric sampling: Proceedings.* 305p. Order Number DE95004052. Source: OSTI; NTIS; GPO Dep.

For many years, the authors measured the evolution of species concentration in premixed flames stabilized on a flat flame burner. Species identification and analyses are performed by using the Molecular Beam-Mass Spectrometric (MBMS) technique. The first studies carried out with this device were related to small fuel molecules: methane and acetylene. More recently, they started new experiments with more realistic fuel: decane and kerosene. Presently, these works are extended to n-heptane and isooctane flames. A large number of intermediates are formed in these flames, and the use of a mass spectrometer for the analysis of heavy hydrocarbons is frequently criticized because fragmentations of these species are likely to occur in the ionization source of the mass spectrometer. To check to which extent fragmentations can affect the accuracy of species concentration measurements the

authors used both the MBMS technique and Gas Phase Chromatography (GPC) to derive mole fraction profiles in a premixed n-heptane-oxygen-argon flame stabilized under low pressure. Some preliminary measurements have been performed as well in the burned gases of isooctane-oxygen-argon flames and will be considered for the same purpose.

30259 (NREL/CP–433-7748, pp. 92-97) **Molecular beam mass-spectrometric study of H_2/O_2/Ar flame doped with phosphorus compounds.** Korobeinichev, O. (Institute of Chemical Kinetics and Combustion, Novosibirsk (Russian Federation)); Chernov, A.; Shvartsberg, V. National Renewable Energy Lab., Golden, CO (United States). Mar 1995. Contract N681719C9056. (CONF-9410343–: Applications of free-jet, molecular beam, mass spectrometric sampling conference, Estes Park, CO (United States), 11-14 Oct 1994). In *Applications of free-jet, molecular beam, mass spectrometric sampling: Proceedings.* 305p. Order Number DE95004052. Source: OSTI; NTIS; GPO Dep.

The combustion of phosphorus compounds (PC) is of a great interest in connection with the disposal of toxic and hazardous chemical wastes and other undesirable substances containing these compounds. One of the most promising technologies for the disposal of wastes is their incineration. This can totally destroy these toxic and hazardous substances. However, for better reliability and control over these processes one needs to know the mechanism of their combustion and especially its chemical details. An alkylphosphate and an alkylphosphonate are typical organophosphorus compounds (OPC). On the one hand, some of them are industrial wastes. For example, tri-n-butylphosphate - TBP - is the product of uranium ore treatment. Phosphorus compounds are applied as additives in polymers for improving their properties. DMMP - dimethyl methylphosphonate - can be used as retardant to polymers. On the other hand, they can be model species for studying the problems of the incinerating pesticides and some of the components of chemical weapons. DMMP is a model simulant of warfare agent sarin. The chemistry of OPC combustion is not understood. Interest in the behavior of phosphorus-containing substances in flames is not limited to the problem of their destruction. These substances (e.g. TMP-trixmethylphosphate, phosphine) can act as inhibitors or promoters of the combustion. The aim of the present paper is to investigate the behavior of TMP and DMMP as typical OPC in a well-studied stoichiometric flame of $H_2 + O_2 + Ar$, stabilized at low pressure on a flat burner. Also this paper deals with the chemistry of these reactions destroying TMP and DMMP in flame. This is achieved by identifying intermediate and end products (including atoms and radicals) by their mass-spectra, and also by measuring the concentration profiles of initial, intermediate and end products. This could well provide a basis for developing a model of OPC combustion.

30260 (NREL/CP–433-7748, pp. 98-103) **Time-of-flight mass spectrometric analysis of reflected shock zone gas mixtures and high speed data analysis.** Kern, R.D. (Univ. of New Orleans, LA (United States)); Chen, H.; Singh, H.J.; Branley, E.A.; Yao, J. National Renewable Energy Lab., Golden, CO (United States). Mar 1995. (CONF-9410343–: Applications of free-jet, molecular beam, mass spectrometric sampling conference, Estes Park, CO (United States), 11-14 Oct 1994). In *Applications of free-jet, molecular beam, mass spectrometric sampling: Proceedings.* 305p. Order Number DE95004052. Source: OSTI; NTIS; GPO Dep.

The shock tube technique has been applied to the study of high temperature gas reactions employing a variety of analytical devices to monitor selected key species. The reader is referred to a recent review of the shock tube literature for examples and as a guide to previous work. The focus herein is on a particular technique; the dynamic sampling of the reflected shock zone by time-of-flight mass spectrometry over typical temperature and total pressure ranges of 1200-2500 K and 0.15 to 0.5 atm. Recent examples involve the thermal decompositions of propargyl chloride and propargyl bromide. A review of previous work devoted to the reactions pertaining to the pre-particle soot formation process is also available. Although the coupling of a shock tube to a time-of-flight mass spectrometer offers the kineticist a well controlled environment to investigate the time histories of major and minor species, it must be acknowledged that there are several deficiencies and problems associated with the technique. The deficiencies are identified as an inability to perform trace analysis, detection of H atoms, differentiation of structural isomers, and limitations on the variability of the total pressure in the reaction zone. Many of these deficiencies are resolved with the reliance on complementary techniques such as laser schlieren densitometry, atomic resonance absorption spectrometry, UV and visible absorption, and single pulse shock tube analysis.

30261 (NREL/CP–433-7748, pp. 104-109) **Mass spectrometry as an efficient tool for kinetic studies in flames.** Vandooren, J. (Universite Catholique de Louvain, Louvain-la-Neuve (Belgium)); Van Tiggelen, P.J. National Renewable Energy Lab., Golden, CO (United States). Mar 1995. (CONF-9410343–: Applications of free-jet, molecular beam, mass spectrometric sampling conference, Estes Park, CO (United States), 11-14 Oct 1994). In *Applications of free-jet, molecular beam, mass spectrometric sampling: Proceedings.* 305p. Order Number DE95004052. Source: OSTI; NTIS; GPO Dep.

Among the analytical techniques regarding flame structure investigations, mass spectrometry has brought numerous data in several burning systems. Spectroscopic analysis using light absorption or emission and laser techniques like CARS or LIF being more and more sophisticated allow now to determine, at least in relative quantities, the evolution of some species throughout the flame. However, this non-intrusive techniques can measure only one or two species at a time. Another technique, but intrusive, the gas chromatography has the advantage to measure all stable species and the sampling can be done with microprobes without strongly perturbing the flame. Unfortunately, the extraction has to be made fast enough to avoid further reactions inside the probe and of course very reactive species like atoms and radicals cannot be recorded. The mass spectrometry coupled with molecular beam sampling allows to monitored by only one technique as well stable species as unstable ones. However, this technique using a large conical sampling probe can induce non negligible perturbations of the flame. In addition, the formation of the molecular beam depends on the pressure behind the probe and the pressure depletion through the orifice must be strong enough to keep unstable species alive. It means that the working pressure at which the flame burns, is generally below one atmosphere. Moreover, the reaction zone of the flame which is generally very thin at atmospheric pressure, needs to be enlarged to ensure a good spatial resolution and to diminish at the same time the perturbing effect of the large probe. This is accomplished by decreasing the working pressure to 10-80 Torr. This paper will present the equipment in some details, the data acquisition conditions, the calibration and data reduction, the comparison of the flame structure with some calculated by using the PREMIX code with different reaction mechanisms, the determination of a rate constant of a reaction like CO + OH.

30262 (NREL/CP–433-7748, pp. 110-115) **Obtaining kinetics from MBMS and modeling of propene flame structure.** Westmoreland, P.R. (Univ. of Massachusetts, Amherst, MA (United States)); Thomas, S.D.; Bhargava, A. National Renewable Energy Lab., Golden, CO (United States). Mar 1995. DOE Contract FG02-91ER14192. (CONF-9410343–: Applications of free-jet, molecular beam, mass spectrometric sampling conference, Estes Park, CO (United States), 11-14 Oct 1994). In *Applications of free-jet, molecular beam, mass spectrometric sampling: Proceedings.* 305p. Order Number DE95004052. Source: OSTI; NTIS; GPO Dep.

Molecular-beam mass spectrometry is being used to map hydrocarbon flat flames for subsequent modeling. The paper focuses on describing the authors' apparatus and its use. Difficulties and solutions for modeling MBMS flame data are discussed using the particular case of a fuel-lean flat flame of propene, oxygen, and argon (ϕ = 0.229, 30 Torr, v_o = 57.5 cm/s at 298 K). Here, the MBMS technique has led to the identification of new kinetics for allyl + O_2 at high temperatures.

30263 (NREL/CP–433-7748, pp. 116-121) **Flame structure studies of neat and NH_3 doped H_2/N_2O flames employing molecular beam mass spectrometry and modeling.** Sausa, R.C. (Army Research Lab., Aberdeen Proving Ground, MD (United States)); Singh, G.; Lemire, G.W. National Renewable Energy Lab., Golden, CO (United States). Mar 1995. (CONF-9410343–:

Applications of free-jet, molecular beam, mass spectrometric sampling conference, Estes Park, CO (United States), 11-14 Oct 1994). In *Applications of free-jet, molecular beam, mass spectrometric sampling: Proceedings.* 305p. Order Number DE95004052. Source: OSTI; NTIS; GPO Dep.

The H_2/N_2O chemical system has received much interest in recent years. Much of this interest stems from the fact that this system is fairly simple and that it has important implications in understanding NO_x pollutant formation, and nitramine propellant combustion and decomposition. The elementary reactions of this system form a subset of a larger mechanism needed to understand the nitrogen chemistry of more complex combustion systems. An understanding of the way additives alter the chemical pathways in combustion systems is a prerequisite for controlling and enhancing system performance. In a recent comprehensive experimental and modeling study of a 20 Torr, burner stabilized flame, the authors reported that the burned gases of the flame contain concentrations of NO and H_2 that are ten times more than that computed from equilibrium calculations. NO, a product of incomplete combustion (PIC), acts as an inhibiter and prevents full energy release of the system within or near the flame zone. This paper reports experimental and modeling studies of $H_2/N_2O/NH_3$ flames in order to explore the conversion of NO to final products by adding trace concentrations of NH_3. NH_3 was used as the additive because of its proven use in the thermal deNO_x process to remove NO from effluent streams of industrial furnaces. Species profiled include H_2, N_2O, NH_3, H_2O, N_2, O_2, and NO. These profiles are compared to calculated profiles generated using PREMIX, a one dimensional premixed laminar flame code. Rate and sensitivity analyses were performed on the PREMIX results using an interactive postprocessing code the authors have written so that the details of the chemistry may be understood. The efficacy of the NH_3 additive on the conversion of NO to N_2, as well as the mechanisms of NO formation from both neat NH_3-doped flames are presented and discussed.

30264 (NREL/CP–433-7748, pp. 122-127) **Molecular beam/mass spectrometric and modeling studies of CF_3Br inhibited flames.** Anderson, W.R. (Army Research Lab., Aberdeen Proving Ground, MD (United States)); Sausa, R.C.; Lemire, G.W. National Renewable Energy Lab., Golden, CO (United States). Mar 1995. (CONF-9410343–: Applications of free-jet, molecular beam, mass spectrometric sampling conference, Estes Park, CO (United States), 11-14 Oct 1994). In *Applications of free-jet, molecular beam, mass spectrometric sampling: Proceedings.* 305p. Order Number DE95004052. Source: OSTI; NTIS; GPO Dep.

The halogenated compound CF_3Br, halon 1301, has been widely used as a flame inhibitor and fire suppression agent. It has been implemented into many fire protection systems dating back as far as the early 1940's. Despite the favorable - experimentally observed flame suppression properties, the detailed chemistry and physics effecting the inhibition in flames by this and similar compounds is not well understood. That there has been very limited research on the chemistry of brominated fire retardants in the past decade is probably due to their known effectiveness and ease of availability. The recent discovery that these bromides promote degradation of the earth's ozone layer and their subsequent use restrictions has, however, led to a resurgence of research on these and other fluorinated hydrocarbons. The purpose of the current studies is to more fully understand the fundamental physical and chemical processes of flame inhibition and to help guide the search for safe and effective replacements. This paper reports new experimental data and results on modeling this data and data from the literature on flames inhibited by CF_3Br. The new experiments were performed on a 20 torr, stoichiometric, premixed, laminar $CH_4/O_2/Ar$ flame with and without 1.6% CF_3Br. Profiles of the detailed structure of the flame were obtained by using MB/MS and thermocouple techniques to measure species concentration and temperature, respectively. These are compared with predicted profiles generated by a premixed laminar flame code using a large detailed mechanism. In addition to modeling of the low pressure detailed structure studies, the model has been used to compute flame speeds for atmospheric pressure conditions at several stoichiometries ranging from rich to lean and for a wide range of CF_3Br concentrations.

30265 (NREL/CP–433-7748, pp. 128-135) **A study of solid propellant combustion using a triple quadrupole mass spectrometer with microprobe sampling.** Litzinger, T.A. (Penn State Univ., University Park, PA (United States)); Lee, Y.; Tank, C.J. National Renewable Energy Lab., Golden, CO (United States). Mar 1995. (CONF-9410343–: Applications of free-jet, molecular beam, mass spectrometric sampling conference, Estes Park, CO (United States), 11-14 Oct 1994). In *Applications of free-jet, molecular beam, mass spectrometric sampling: Proceedings.* 305p. Order Number DE95004052. Source: OSTI; NTIS; GPO Dep.

RDX (1,3,5-trinitrohexahydro-s-triazine) is a highly energetic material which is used in solid propellants in rocket motors and artillery guns. While a substantial amount of literature has been published on RDX, its complicated combustion behavior, which involves chemical reactions in the solid, liquid and gas-phases, is not yet fully understood. In order to better understand the gas-phase chemical reactions of RDX and propellants with RDX as the primary ingredient, a study of the gas-phase chemistry of these materials has been undertaken using a triple quadrupole mass spectrometer and quartz microprobe sampling. In this abstract, after a summary of the experimental apparatus, results are presented for the analysis of masses 28, 29 and 30 as well as complete results for a typical test with RDX mono-propellant.

30266 (NREL/CP–433-7748, pp. 136-145) **Application of simultaneous thermogravimetric modulated beam mass spectrometry to the study of energetic materials.** Behrens, R. Jr. (Sandia National Labs., Livermore, CA (United States)). National Renewable Energy Lab., Golden, CO (United States). Mar 1995. DOE Contract AC04-94AL85000. (CONF-9410343–: Applications of free-jet, molecular beam, mass spectrometric sampling conference, Estes Park, CO (United States), 11-14 Oct 1994). In *Applications of free-jet, molecular beam, mass spectrometric sampling: Proceedings.* 305p. Order Number DE95004052. Source: OSTI; NTIS; GPO Dep.

Simultaneous thermogravimetric modulated beam mass spectrometry (STMBMS) and time-of-flight velocity (TOF) spectra have been developed to study reactions that occur during the thermal decomposition of liquids and solids. The data obtained with these techniques are the identity of the reaction products and their rates of gas formation as a function of time. Over the past several years, these techniques have been applied to the study of energetic materials that are used in propellants and explosives. In this presentation, the details of the STMBMS and TOF velocity spectra techniques will be reviewed, the advantages of the techniques over more conventional thermal analysis and mass spectrometry measurements will be discussed, and the use of the techniques will be illustrated with results on the thermal decomposition of hexahydro-1,3,5-s-triazine (RDX).

30267 (NREL/CP–433-7748, pp. 146-151) **Determination of mass and velocity distributions of soot particles in a nozzle beam from a flame by means of a Wien filter.** Homann, K.H. (Institute fuer Physikalische Chemie, Darmstadt (Germany)); Wiese, W. National Renewable Energy Lab., Golden, CO (United States). Mar 1995. (CONF-9410343–: Applications of free-jet, molecular beam, mass spectrometric sampling conference, Estes Park, CO (United States), 11-14 Oct 1994). In *Applications of free-jet, molecular beam, mass spectrometric sampling: Proceedings.* 305p. Order Number DE95004052. Source: OSTI; NTIS; GPO Dep.

Size distributions of soot particles in flames have mainly been determined from electron micrographs of particles. However, there is a limit of about 3 nm below which the uncertainty in particle diameter determined in this way becomes too large for a sufficiently accurate mass determination. For an understanding of the soot formation mechanism it is of particular interest to study the mass growth of the first soot particles after their inception from large hydrocarbon molecules. This concerns a mass range of some 10^3 to some 10^4 u. High-resolution mass spectrometry (MS) has the shortcoming that ionization of soot particles in an ion source does not seem to be very effective. Furthermore, the sensitivity of the usually applied electron multiplier detectors decreases with ion mass in a uncontrollable way. The authors therefore developed a new method for the mass analysis of very small particles. Charged

soot particles can be sampled from low-pressure flames via a nozzle beam which generates a current large enough to be measured with a Faraday detector and a sensitive electrometer. Their mass distribution is quasi-continuous so that high mass resolution is not necessary.

30268 (NREL/CP–433-7748, pp. 152-158) **Studies of volatile high temperature corrosion products via the free-jet MBMS technique.** Jacobson, N.S. (NASA Lewis Research Center, Cleveland, OH (United States)). National Renewable Energy Lab., Golden, CO (United States). Mar 1995. (CONF-9410343–: Applications of free-jet, molecular beam, mass spectrometric sampling conference, Estes Park, CO (United States), 11-14 Oct 1994). In *Applications of free-jet, molecular beam, mass spectrometric sampling: Proceedings.* 305p. Order Number DE95004052. Source: OSTI; NTIS; GPO Dep.

In high temperature applications such as heat engines, heat exchangers, and chemical process plants, metal and ceramic structural materials are exposed to harsh chemical environments. It is important to understand the mechanism of corrosion of these materials under such conditions. Most laboratory studies of corrosion involve a sensitive microbalance with the sample suspended in a furnace and particular gas atmosphere (thermogravimetric apparatus–TGA). This system allows one to follow the kinetics of reaction and then characterize the corrosion products. Corrosion products are often condensed phase oxides, sulfides, carbides, etc. However, they may often be volatile products such as volatile oxides, hydroxides, chlorides, and oxychlorides. In a TGA, these form as down-stream deposits, which must be chemically analyzed after an experiment. In such a "pseudo-transpiration" experiment, speculations can then be made regarding the composition of these vapor species. Clearly, an in-situ mass spectrometric sampling method is far superior for such analysis. The free-jet expansion, molecular beam mass spectrometric technique allows direct identification of these species. The features of this technique–a rapid transition to collisionless flow, beam cooling, and a high velocity molecular beam–preserve the chemical and dynamic integrity of the beam. In this paper, several studies on volatile corrosion products will be summarized. It will be shown how the mass spectrometric results are combined with other data to elucidate the reaction mechanism. These studies fall into two categories: volatile chlorides and oxychlorides, and volatile hydroxides. Corrosion by chlorine occurs in waste incineration and chemical process plants; formation of volatile hydroxides occurs in combustion environments since water is always a product of combustion.

30269 (NREL/CP–433-7748, pp. 181-186) **Molecular beam mass spectrometry studies of the thermal decomposition of tetraethoxysilane (TEOS).** Wierda, C.A. (National Institute of Standards and Technology, Gaithersburg, MD (United States)); Zachariah, M.R.; Burgess, D.R.F. Jr. National Renewable Energy Lab., Golden, CO (United States). Mar 1995. (CONF-9410343–: Applications of free-jet, molecular beam, mass spectrometric sampling conference, Estes Park, CO (United States), 11-14 Oct 1994). In *Applications of free-jet, molecular beam, mass spectrometric sampling: Proceedings.* 305p. Order Number DE95004052. Source: OSTI; NTIS; GPO Dep.

Molecular beam mass spectrometry and time-of-flight techniques have been used to reveal the gas phase chemistry that occurs during the thermal decomposition of TEOS. Evidence in the authors' laboratory was consistent with the presence of the following species during decomposition at 600°C: ethylene, ethanol, acetaldehyde, possibly diethoxysilanone, triethoxysilanol, hexaethoxysiloxane. A grayish white powder, which presumably consists of silicon oxides containing residual carbon and hydrogen, was also produced. Under the following reaction conditions: reactor pressure=266 Pa (2 torr), residence time=6 ms, and TEOS partial pressure=26 Pa (0.2 torr), the onset of decomposition occurs at 400°C. The amount of TEOS decreases at residence times greater than 6 ms with concurrent increase in ethanol and ethylene. Hexaethoxysiloxane also increases at residence times between 6 and 20 ms, but then decreases at longer times probably because it reacts to form larger siloxanes and silicon oxides.

30270 (NREL/CP–433-7748, pp. 187-192) **Mass discrimination effects in MBMS study of rich premixed flames.** Vovelle, C. (Laboratoire de Combustion et Systemes Reactifs, Orleans (France)); Doute, C.; Delfau, J.L. National Renewable Energy Lab., Golden, CO (United States). Mar 1995. (CONF-9410343–: Applications of free-jet, molecular beam, mass spectrometric sampling conference, Estes Park, CO (United States), 11-14 Oct 1994). In *Applications of free-jet, molecular beam, mass spectrometric sampling: Proceedings.* 305p. Order Number DE95004052. Source: OSTI; NTIS; GPO Dep.

Sampling by formation of a molecular beam in mixtures containing both light and heavy species can be affected by mass discrimination effects. This situation is faced in rich premixed flames where H_2 and H atoms are present in high concentration in mixture with heavier combustion products. This paper describes the results of a specific study carried out to derive a procedure that takes into account these effects and improves the accuracy of H_2 and H measurements in flames. A three stage Molecular Beam Mass Spectrometer (MBMS) apparatus especially designed for the experimental determination of the structure of low pressure premixed flames has been used to study the effect of temperature (T) and mean molar mass (M) on the signals measured for species in mixtures of known composition. Variations of T and M where aimed at reproducing the evolution observed in flames when the sampling probe is moved from unburned, (low T, high M) to burned gases (high T, low M). However, as temperature variations were limited to the range 300-800K, the pressure was also varied from 13 down to 0.8 kPa to create sample density conditions equivalent to those prevailing in post flame gases. Most measurements have been performed with $H_2/CH_4/N_2/O_2/Ar/CO_2$ mixtures while variations of the mean molar mass were achieved with binary H_2/Ar mixtures.

30271 (NREL/CP–433-7748, pp. 193-199) **Study of solid propellant flame structure by mass-spectrometric sampling, including MBMS.** Korobeinichev, O.P. (Institute of Chemical Kinetics and Combustion, Novosibirsk (Russian Federation)); Kuibida, L.V.; Paletskii, A.A. National Renewable Energy Lab., Golden, CO (United States). Mar 1995. (CONF-9410343–: Applications of free-jet, molecular beam, mass spectrometric sampling conference, Estes Park, CO (United States), 11-14 Oct 1994). In *Applications of free-jet, molecular beam, mass spectrometric sampling: Proceedings.* 305p. Order Number DE95004052. Source: OSTI; NTIS; GPO Dep.

At present the most effective and universal experimental technique for studying the condensed systems (including solid propellants) flame structure is the method of mass-spectrometric probing of condensed system (CS) flames (MSPCSF) which was improved in the authors laboratory in 1975. It allows to record all stable species present in the flame as well as the structure of CS flame with the resolution sufficient to study CS combustion at low pressures. The use of spectroscopic methods requires certain parameters which are not available. The MSPCSF method consists in the following: a burning stand of solid propellant moves with a speed exceeding the burning rate towards the probe so that the probe is sampling continuously the gaseous species from all the zones including those adjacent to the burning surface. The sample is transported to the ion source of a time-of-flight (TOF) or quadrupole (QMS) mass-spectrometer. The mass spectra of samples are recorded with simultaneous filming of the probe and burning surface. The data allow one to identify stable components, to determine their concentrations and spatial distributions, i.e. to study the flame microstructure.

30272 (NREL/CP–433-7748, pp. 243-249) **Molecular beam, mass spectrometric sampling in hazardous waste destruction.** Nimlos, M.R. (National Renewable Energy Lab., Golden, CO (United States)); Milne, T.A.; McKinnon, J.T. National Renewable Energy Lab., Golden, CO (United States). Mar 1995. (CONF-9410343–: Applications of free-jet, molecular beam, mass spectrometric sampling conference, Estes Park, CO (United States), 11-14 Oct 1994). In *Applications of free-jet, molecular beam, mass spectrometric sampling: Proceedings.* 305p. Order Number DE95004052. Source: OSTI; NTIS; GPO Dep.

This paper describes the study of the destruction of hazardous waste in which compounds and conditions are screened and byproducts are detected with a molecular beam, mass spectrometer (MBMS). Three destruction techniques were investigated as

potential solar-driven processes: catalytic steam reforming, photothermal oxidation, and photocatalytic oxidation. These processes were investigated using an MBMS-equipped with a triple quadrupole mass spectrometer. The MS/MS capabilities of this instrument were used to characterize products using daughter and parent ion scanning modes. With catalytic steam reforming, a number of chlorinated and nonchlorinated compounds were screened for their susceptibility to destruction using a rhodium catalyst. The destruction efficiencies were high at modest temperatures (700-900°C) and few byproducts were measured. Choloronaphthalene was studied as a model compound for the photothermal oxidation processes. An enhancement in the destruction rate in air was measured by adding near UV light (300-340 nm). Byproducts were measured and the identities of these products were determined using daughter ion MS/MS spectrometry. The gas-phase photocatalytic oxidation of trichloroethylene (TCE) was measured at ambient temperatures using the MBMS. The identity of these byproducts was determined using parent ion MS/MS spectrometry.

30273 (NREL/CP–433-7748, pp. 268-274) **A study of sampling phenomena in a probe nozzle for high temperature MBMS.** Smirnov, V.I. (Ivanovo State Univ. (Russian Federation)). National Renewable Energy Lab., Golden, CO (United States). Mar 1995. (CONF-9410343–: Applications of free-jet, molecular beam, mass spectrometric sampling conference, Estes Park, CO (United States), 11-14 Oct 1994). In *Applications of free-jet, molecular beam, mass spectrometric sampling: Proceedings.* 305p. Order Number DE95004052. Source: OSTI; NTIS; GPO Dep.

One important and difficult problem of MBMS is sampling from high temperature systems containing condensable high temperature molecules, for example oxides and hydroxides of d- and f-elements. Condensation in the orifice of a probe nozzle is one of the main difficulties in a practical mass sectrometric, analysis of environments which contain highly volatile compounds. Due to condensation the concentrations of compounds in a probe may be changed, therefore the composition in a source may significantly differ from the composition in the mass spectrometric detector. The orifice of a nozzle is plugged in a short time if condensation on the surface of a nozzle is very intensive. Plugging significantly reduces the signal registration time and the sensitivity. There are many classes of important compounds which cannot be analyzed by MBMS due to these limitations. For example, oxides and hydroxides of d- and f-elements, play the main role in many application systems. To develop a nozzle with a low level of condensation in it, it is essential to understand the quantitative picture of the sampling phenomena - gas dynamic structure, chemical and energetic relaxation, kinetics of homogeneous and heterogeneous condensation etc. To define the state and the composition of a probe in a mass spectrometer ion source it is necessary to build a quantitative model which describes all prehistory of the gas probe from the starting point of acceleration in front of the nozzle to the range of a free molecular flow.

30274 (NREL/CP–433-7748, pp. 289-294) **Quantitative measurement of radical intermediates by molecular-beam-sampling-mass-spectrometry.** Chang, A.Y. (Exxon Research and Engineering Co., Annandale, NJ (United States)); Dean, A.M.; Weisel, M.D. National Renewable Energy Lab., Golden, CO (United States). Mar 1995. (CONF-9410343–: Applications of free-jet, molecular beam, mass spectrometric sampling conference, Estes Park, CO (United States), 11-14 Oct 1994). In *Applications of free-jet, molecular beam, mass spectrometric sampling: Proceedings.* 305p. Order Number DE95004052. Source: OSTI; NTIS; GPO Dep.

Complementary advances in theory and experiment have provided significant new insights into the complex chemistry occurring during high temperature pyrolysis and combustion. Detailed models have been developed for reactions in flames and engines as well as hydrocarbon pyrolysis. Such detailed models are generally considered to be more reliable if they can successfully describe the behavior of reactive intermediates, since these are usually much more sensitive to subtle details of the chemistry than either the reactants or products. In particular, accurate knowledge of the concentration-time profiles of these intermediates provide a rigorous test of the accuracy of the proposed kinetic model. The authors use a molecular-beam-sampling apparatus which utilizes both a vacuum ultraviolet photoionization time-of-flight spectrometer and an electron-impact quadrupole spectrometer to measure reactive intermediates as well as stable products of flow tube experiments.

30275 (NREL/CP–433-7748, pp. 295-299) **A new MBMS flame chamber for the study of molecular weight growth reactions.** Yeh, L.I. (Exxon Research and Engineering, Annandale, NJ (United States)); Creegan, K.M. National Renewable Energy Lab., Golden, CO (United States). Mar 1995. (CONF-9410343–: Applications of free-jet, molecular beam, mass spectrometric sampling conference, Estes Park, CO (United States), 11-14 Oct 1994). In *Applications of free-jet, molecular beam, mass spectrometric sampling: Proceedings.* 305p. Order Number DE95004052. Source: OSTI; NTIS; GPO Dep.

A description of the new molecular beam/mass spectrometer flame chamber just constructed is given. The purpose of this system is to study molecular weight growth reactions leading to soot precursors as a function of flame conditions including fuel composition. Formation of the first aromatic rings is believed to be the bottleneck to soot formation and will be the focus of the authors initial studies. Because radicals are crucial to molecular weight growth reactions, this chamber has been designed to optimize radical detection from premixed flames. The chosen fuel, oxidant, and inert gases flow through MKS mass flow controllers to a sintered bronze McKenna burner. The diameter of the burner is 2.5 inches and the diameter of the concentric shroud ring is 2.9 inches. The pressure in this region is maintained at 30 torr using a Roots blower with choked flow as well as a feedback loop controlling a valve to an argon line. The burner is mounted on a movable bellows assembly with a travel of over 6 inches in the Z direction. This allows different positions in the flame to be sampled by a quartz cone custom made by Finkenbeiner. The cone is of the "hybrid" shape with an angle of 40° near the tip and 90° at the base. The tip of the cone has a 115 μm hole and a wall thickness of 50-100 μm. This serves as the nozzle for a supersonic expansion into the first differential pumping region. At this point, collisions cease allowing the very reactive radicals to survive in the molecular beam. The pressure in this first differential region is typically low 10^{-4} to high 10^{-5} torr when the main chamber is at 30 torr. The beam path in this region is defined on one end by the quartz cone and on the other by a movable skimmer. The skimmer is mounted on a bellows assembly allowing the nozzle-skimmer distance to vary from less than 1 inch to 2.7 inches. A schematic of the skimmer assembly is shown.

30276 (UCRL-ID–118941) **Ethylene oxidation in a well-stirred reactor.** Marinov, N.M. (Lawrence Livermore National Lab., CA (United States)); Malte, P.C. Lawrence Livermore National Lab., CA (United States). Oct 1994. 55p. Sponsored by USDOE, Washington, DC (United States). DOE Contract W-7405-ENG-48. Order Number DE96000820. Source: OSTI; NTIS; GPO Dep.

The detailed ethylene oxidation data set of Thornton, obtained for a well-stirred reactor operated fuel-lean at atmospheric pressure and for temperatures of 1003K to 1253K, is used as a basis for the comparison of chemical kinetic mechanisms reported in the literature and for the development of a new ethylene oxidation mechanism. The mechanisms examined are those of Westbrook and Pitz and Dagaut et al. These mechanisms indicated that unusually large rates for the vinyl decomposition reaction are required to obtain agreement with the Thornton data set. A new ethylene oxidation mechanism is developed in order to overcome some of the drawbacks of the previous mechanisms. The new mechanism closely simulates the overall rate of loss of ethylene, and the concentation of CO, CO_2, H_2, CH_2O, C_2H_2, CH_3OH, CH_4, and C_2H_6 measured for the stirred reactor. Predictions by this mechanism are dependent on a new high temperature vinyl oxidation route, $C_2H_3 + O_2 = CH_2CHO + O$ with a $k_{C2H3+O2=CH2CHO+O}/k_{C2H3+O2=CH2O+HCO}$ branching ratio of 1.20 at 1053K to 2.05 at 1253K. The branching ratio values were dependent upon the extent of fall-off for the $C_2H_3 + O_2 = CH_2O + HCO$ reaction.

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Refer also to citation(s) 29426, 29427, 30210

30277 (SAND–95-0536) **A process for the agile product realization of electro-mechanical devices.** Forsythe, C.; Diegert, K.V.; Ashby, M.R.; Parratt, S.W.; Benavides, G.L.; Jones, R.E.; Longcope, D.B. Sandia National Labs., Albuquerque, NM (United States). Aug 1995. 46p. Sponsored by USDOE, Washington, DC (United States). DOE Contract AC04-94AL85000. Order Number DE95017636. Source: OSTI; NTIS; GPO Dep.

This paper describes a product realization process developed at Sandia National Laboratories by the A-PRIMED project that integrates many of the key components of "agile manufacturing" into a complete, step-by-step, design-to-production process. For three separate product realization efforts, each geared to a different set of requirements, A-PRIMED demonstrated product realization of a custom device in less than a month. A-PRIMED used a discriminator (a precision electro-mechanical device) as the demonstration device, but the process is readily adaptable to other electro-mechanical products. The process begins with a qualified design parameter space. From that point, the product realization process encompasses all facets of requirements development, analysis and testing, design, manufacturing, robotic assembly and quality assurance, as well as product data management and concurrent engineering. In developing the product realization process, A-PRIMED employed an iterative approach whereby after each of three builds, the process was reviewed and refinements made on the basis of lessons learned. This paper describes the integration of project functions and product realization technologies, with references to reports detailing specific facets of the overall process. The process described herein represents the outcome of an empirically-based process development effort that on repeated iterations, was proven successful.

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Refer also to citation(s) 28675, 28779, 28784, 28841, 28901, 28916, 28994, 29003, 29005, 29096, 29121, 29163, 29432, 29433, 29435, 29523, 29540, 29787, 29830, 30061, 30348, 30350, 30352, 30410, 30559, 30560, 30564, 30572, 30870, 30884, 30892, 31101, 31151, 31225, 31319, 31325, 31326, 31328, 31332, 31369, 31371

30278 (ANL–95/30) **Nonlinear dynamics of a stack/cable system.** Cai, Y.; Chen, S.S. Argonne National Lab., IL (United States). Jul 1995. 47p. Sponsored by USDOE, Washington, DC (United States). DOE Contract W-31109-ENG-38. Order Number DE96000980. Source: OSTI; NTIS; GPO Dep.

In this study, we developed a coupled model of wind-induced vibration of a stack, based on an unsteady-flow theory and nonlinear dynamics of the stack's heavy elastic suspended cables. Numerical analysis was performed to identify excitation mechanisms. The stack was found to be excited by vortex shedding. Once lock-in resonance occurred, the cables were excited by the transverse motion of the stack. Large-amplitude oscillations of the cables were due to parametric resonance. Appropriate techniques have been proposed to alleviate the vibration problem.

30279 (ANL/ET/CP–86568) **A guide for the ASME code for austenitic stainless steel containment vessels for high-level radioactive materials.** Raske, D.T. Argonne National Lab., IL (United States). [1995]. 13p. Sponsored by USDOE, Washington, DC (United States). DOE Contract W-31-109-ENG-38. (CONF-951203–2: 11. international conference on packaging and transportation of radioactive materials, Las Vegas, NV (United States), 3-8 Dec 1995). Order Number DE95013550. Source: OSTI; NTIS; INIS; GPO Dep.

The design and fabrication criteria recommended by the US Department of Energy (DOE) for high-level radioactive materials containment vessels used in packaging is found in Section III, Division 1, Subsection NB of the ASME Boiler and Pressure Vessel Code. This Code provides material, design, fabrication, examination, and testing specifications for nuclear power plant components. However, many of the requirements listed in the Code are not applicable to containment vessels made from austenitic stainless steel with austenitic or ferritic steel bolting. Most packaging designers, engineers, and fabricators are intimidated by the sheer volume of requirements contained in the Code; consequently, the Code is not always followed and many requirements that do apply are often overlooked during preparation of the Safety Analysis Report for Packaging (SARP) that constitutes the basis to evaluate the packaging for certification.

30280 (BNL–62219) **A plane strain model of soil saturation effect on dynamic stiffness functions of embedded footings.** Simos, N. (Brookhaven National Lab., Upton, NY (United States)); Philippacopoulos, A.J.; Reich, M.; McSpadden, T. Brookhaven National Lab., Upton, NY (United States). [1995]. 10p. Sponsored by USDOE, Washington, DC (United States). DOE Contract AC02-76CH00016. (CONF-9511128–4: DOE natural phenomena hazards mitigation symposium, Denver, CO (United States), 13-14 Nov 1995). Order Number DE96000416. Source: OSTI; NTIS; GPO Dep.

Impedance functions associated with horizontal and vertical vibrations of rigid massless strip footings embedded in a saturated soil stratum are evaluated using a finite element approach The foundation medium is treated as a two-phase continuum which behaves according to Biot's classical theory of wave propagation in fluid-saturated porous media. Parametric studies have been recently performed by the authors in an effort to verify that the adopted finite element approach and associated numerical procedures yield reasonable correlations with analytic solutions of soil-structure interaction problems. Horizontal and vertical impedance functions are presented for various embedment depth/soil layer thickness configurations. It is shown that saturation influences the foundation impedances especially their imaginary parts which can be reasonably explained as being the result of additional dissipation in the system associated with the motion of pore fluid relative to the soil skeleton. It is further shown that, as anticipated, soil stiffnesses increase with increasing embedment depth.

30281 (CONF-9410231–3) **Model of rotary-actuated flexible beam with notch filter vibration suppression controller and torque feedforward load compensation controller.** Bills, K.C. (Oak Ridge National Lab., TN (United States)); Kress, R.L.; Kwon, D.S.; Baker, C.P. Oak Ridge National Lab., TN (United States). [1994]. 8p. Sponsored by USDOE, Washington, DC (United States). DOE Contract AC05-84OR21400. From 8. Deneb user group meeting; Detroit, MI (United States); 10-14 Oct 1994. Order Number DE95014254. Source: OSTI; NTIS; INIS; GPO Dep.

This paper describes ORNL's development of an environment for the simulation of robotic manipulators. Simulation includes the modeling of kinematics, dynamics, sensors, actuators, control systems, operators, and environments. Models will be used for manipulator design, proposal evaluation, control system design and analysis, graphical preview of proposed motions, safety system development, and training. Of particular interest is the development of models for robotic manipulators having at least one flexible link. As a first application, models have been developed for the Pacific Northwest Laboratory's Flexible Beam Test Bed (PNL FBTB), which is a 1-Degree-of-Freedom, flexible arm with a hydraulic base actuator. ORNL transferred control algorithms developed for the PNL FBTB to controlling IGRIP models. A robust notch filter is running in IGRIP controlling a full dynamics model of the PNL test bed. Model results provide a reasonable match to the experimental results (quantitative results are being determined) and can run on ORNL's Onyx machine in approximately realtime. The flexible beam is modeled as six rigid sections with torsional springs between each segment. The spring constants were adjusted to match the physical response of the flexible beam model to the experimental results. The controller is able to improve performance on the model similar to the improvement seen on the experimental system. Some differences are apparent, most notably because the IGRIP model presently uses a different trajectory planner than the one used by ORNL on the PNL test bed. In the future, the trajectory planner will be modified so that the experiments and models are the same. The successful completion of this work provides the ability to link C code with IGRIP, thus allowing controllers to be developed, tested, and tuned in simulation and then ported directly to hardware systems using the C language.

30282 (CONF-941207–38) **DOE spent nuclear fuel – Nuclear criticality safety challenges and safeguards initiatives.** Hopper, C.M. Oak Ridge National Lab., TN (United States). [1994]. 9p. Sponsored by USDOE, Washington, DC (United States). DOE

Contract AC05-84OR21400. From Spent nuclear fuel meeting: challenges and initiatives; Salt Lake City, UT (United States); 14-16 Dec 1994. Order Number DE95016364. Source: OSTI; NTIS; INIS; GPO Dep.

The field of nuclear criticality safety is confronted with growing technical challenges and the need for forward-thinking initiatives to address and resolve issues surrounding economic, safe and secure packaging, transport, interim storage, and long-term disposal of spent nuclear fuel. These challenges are reflected in multiparameter problems involving optimization of packaging designs for maximizing the density of material per package while ensuring subcriticality and safety under variable normal and hypothetical transport and storage conditions and for minimizing costs. Historic and recently revealed uncertainties in basic data used for performing nuclear subcriticality evaluations and safety analyses highlight the need to be vigilant in assessing the validity and range of applicability of calculational evaluations that represent extrapolations from "benchmark" data. Examples of these uncertainties are provided. Additionally, uncertainties resulting from the safeguarding of various forms of fissionable materials in transit and storage are discussed.

30283 (DOE/ER/14444–1) **Atomic physics with highly charged ions. Progress report, September 1, 1994–August 31, 1995.** Richard, P. Kansas State Univ., Manhattan, KS (United States). Dept. of Physics. Sep 1995. 6p. Sponsored by USDOE, Washington, DC (United States). DOE Contract FG02-94ER14444. Order Number DE95017586. Source: OSTI; NTIS; GPO Dep.

Grant DE-FG02-94ER14444 was obtained from the FY94 ARIM fund account of Energy Research. These funds were requested to address several upgrades of the Macdonald Laboratory facility. The largest item is the relocation and upgrade of the He compressor associated with providing LHe to the Nb split-ring superconducting LINAC accelerator and the superconducting CRYEBIS ion source. The move is prompted by the need to reduce the noise and vibration levels in the personnel working space in the laboratory. Several other issues related to the relocation are being addressed at the same time, such as additional electrical service and overhead crane for compressor maintenance. The Ion-Compressor Relocation Project consists of six major components. All necessary planning and engineering are completed. Many of the upgrades consist of obtaining commercially available items which are being installed by our local staff in the Macdonald Laboratory. No unexpected complications stand in the way of completing all projects within the scope, budget and time frame of the project. Of the project's major components, the tandem resistor upgrade, tandem foil stripper upgrade, and LINAC upgrade are all complete, the CRYEBIS upgrade is partially completed and on schedule, the LHe compressor upgrade is in the early stages of development and is on schedule, and the RF electronics upgrade is in progress. (The LINAC upgrade replaces the beam scanner item.)

30284 (DOE/ER/40537–50) **Terminal ion source for an FN tandem.** Harper, G.C. Washington Univ., Seattle, WA (United States). Nuclear Physics Lab. [1995]. 5p. Sponsored by USDOE, Washington, DC (United States). DOE Contract FG06-90ER40537. (CONF-9509230–2: 7. international conference on heavy ion accelerator technology, Canberra (Australia), 18-22 Sep 1995). Order Number DE95017518. Source: OSTI; NTIS; INIS; GPO Dep.

An RF discharge source assembly has been developed for use in the terminal of the FN tandem van de Graaff accelerator at the Nuclear Physics Laboratory of the University of Washington. The primary motivation for developing the source was to provide a high intensity beam of $^{3}He^{+}$ to produce ^{8}B from the reaction $_{6}Li(^{3}He,n)^{8}B$. The design of the optics and the performance of the source are described here.

30285 (DOE/OR/21400–T488) **Final report Brown and Sharpe CRADA, CRADA 92-0090.** Tennery, V.J.; Parten, R.J. Oak Ridge National Lab., TN (United States). 31 Dec 1994. 25p. Sponsored by USDOE, Washington, DC (United States). DOE Contract AC05-84OR21400. Order Number DE96000669. Source: OSTI; NTIS; GPO Dep.

This CRADA technically started in October 1992, for a two year period, and the major component of the agreement was for the Brown and Sharpe company to provide a Leitz Model 654 Coordinate Measuring Machine for installation in the HTML and for HTML staff to conduct a series of studies to demonstrate the capabilities of this sophisticated metrology instrument. Mr. Mike Majlak was the contact at Brown and Sharpe. V.J. Tennery was the contact at ORNL. The CRADA agreement included two major phases, Phase I and Phase II. Phase I included instrument delivery, set up and calibration, plus the start of a series of repetitive measurements on reference bars to determine long term stability of the instrument. The instrument delivery occurred late and installation was only completed on April 30, 1993, therefore useful work during the first six months of this agreement was greatly reduced compared to the planned rate of progress.

30286 (EFR-TDD–950060) **Savannah River Site Surplus Facilities Available for Reuse.** Clarke, R.M.; Owens, M.B.; Lentz, D.W. Westinghouse Savannah River Co., Aiken, SC (United States). 14 Sep 1995. 20p. Sponsored by USDOE, Washington, DC (United States). DOE Contract AC09-89SR18035. Order Number DE96060012. Source: OSTI; NTIS; INIS; GPO Dep.

The purpose of this document is to provide a current, centralized list of Savannah River Site facilities, which are surplus and available for reuse. These surplus facilities may be made available for other DOE site missions, commercial economic development reuse, or other governmental reuse. SRS procedures also require that before new construction can be approved, available surplus facilities are screened for possible reuse in lieu of the proposed new construction.

30287 (INEL–94/00106) **Evaluation of a potential nuclear fuel repository criticality: Lessons learned.** Wilson, J.R.; Evans, D. Lockheed Idaho Technologies Co., Idaho Falls, ID (United States). [1995]. 10p. Sponsored by USDOE, Washington, DC (United States). DOE Contract AC07-94ID13223. (CONF-950740–99: Joint ASME/JSME pressure vessels and piping conference, Honolulu, HI (United States), 23-27 Jul 1995). Order Number DE96001616. Source: OSTI; NTIS; INIS; GPO Dep.

This paper presents lessons learned from a Probabilistic Risk Assessment (PRA) of the potential for a criticality in a repository containing spent nuclear fuel with high enriched uranium. The insights gained consisted of remarkably detailed conclusions about design issues, failure mechanisms, frequencies and source terms for events up to 10,000 years in the future. Also discussed are the approaches taken by the analysts in presenting this very technical report to a nontechnical and possibly antagonistic audience.

30288 (INEL–95/00079) **Human factors issues for resolving adverse effects of human work underload and workload transitions in complex human-machine systems.** Ryan, T.G. Idaho National Engineering Lab., Idaho Falls, ID (United States). [1995]. 17p. Sponsored by Nuclear Regulatory Commission, Washington, DC (United States). DOE Contract AC07-94ID13223. (CONF-950434–3: International topical meeting on safety culture in nuclear installations, Vienna (Austria), 24-28 Apr 1995). Order Number DE96001625. Source: OSTI; NTIS; GPO Dep.

A workshop was conducted whose specific purpose was to build on earlier work of the United States National Research Council, United States Federal government agencies, and the larger human factors community to: (1) clarify human factors issues pertaining to degraded performance in advanced human-machine systems (e.g., nuclear production, transportation, aerospace) due to human work underload and workload transition, and (2) develop strategies for resolving these issues. Recent history demonstrates that: (1) humans often react adversely to their diminishing roles in advanced human-machine systems, and therefore (2) new allocation models and strategies are required if humans are to be willing and able to assume diminishing and shifting roles assigned to them in these systems, and are to accept new technologies making up these systems. Problems associated with theses diminishing and shifting human roles are characterized as work underload and workload transitions. The workshop affirmed that: (1) work underload and workload transition are issues that will have to be addressed by designers of advanced human-machine systems, especially those relying on automation, if cost, performance, safety, and operator acceptability are to be optimized, (2) human machine allocation

models, standards, and guidelines which go beyond simple capability approaches will be needed to preclude or seriously diminish the work underload and workload transition problems, and (3) the 16 workload definition, measurement, situational awareness, and trust issues identified during the workshop, need resolution if these models, standards, and guidelines are to be achieved.

30289 (JAERI-Data/Code–95-007) **Revised VESCAL: Vessel calibration data analysis program. Improvement of a model for non-linear parts of annular and slab tanks.** Yanagisawa, Hiroshi (Japan Atomic Energy Research Inst., Tokai, Ibaraki (Japan). Tokai Research Establishment). Japan Atomic Energy Research Inst., Tokyo (Japan). May 1995. 95p. (In Japanese). Order Number DE96701321. Source: OSTI; NTIS; INIS.

For the purpose of the nuclear material accountancy and control for NUCEF: the Nuclear Fuel Cycle Safety Engineering Research Facility, the vessel calibration data analysis program: VESCAL is revised, and a new model for non-linear parts of annular and slab tanks is added to the program. The new model has three unknown parameters, and liquid level is expressed as a square root function with respect to liquid volume. Using the new model, an accurate calibration function on the level and volume data for non-linear parts of annular and slab tanks can be obtained with the smaller number of unknown parameters, compared with a polynomial function model. As a result of benchmark tests for this revision, it was proved that numerical results computed with VESCAL well agreed with those by a statistical analysis program package which is widely used. In addition, the new model would be useful for carrying out data analyses on the vessel calibration at the other bulk handling facilities as well as at NUCEF. This paper describes summary of the program, computational methods and results of benchmark tests concerning this revision. (author).

30290 (KRC–90G-05) **Development of Acoustic Emission Monitoring Techniques of Bearings in Rotating Machinery High-Temperature Facilities.** Hong, S.E. (Korea Electric Power Corp. (KEPCO), Taejon (Korea, Republic of). Research Center); Chung, M.H.; Cho, Y.S.; Kim, Y.H.; Lee, K.Y.; Park, J.S.; Choi, J.G.; Kwan, O.Y.; Bhang, K.W.; Kim, Y.H.; Yoon, D.J.; Choi, M.Y.; Kim, Y.J.; Kim, B.K.; Kim, D.H.Korea Electric Power Corp. (KEPCO), Taejon (Korea, Republic of). Research Center. 1993. 468p. (In Korean). Order Number DE96703585. Source: OSTI; NTIS (US Sales Only).

Generally, journal bearing in the rotating machineries are vulnerable to the contamination or the insufficient supply of lubricating oil, which is likely to be the cause of unexpected shutdown or malfunction of these systems. To avoid the time consuming repair and considerable economic loss, the detection of incipient failure in journal bearings becomes very important. In this study, acoustic emission monitoring is employed to the detection of incipient failure caused by several types of abnormal operating condition most probable in the journal bearing systems. the results of experimental study in laboratory showed that acoustic emission could be an effective tool to detect the incipient failure in journal bearings. And practical applications for AE monitoring of bearings have been studied with actual bearing in the unit No.1 of Boopying Internal Combustion Power Plant. Also, as the final results of this study, the monitoring system for journal bearing diagnosis by AE was Developed.

30291 (KRC–90G-J06) **A Study on the Crack Growth Analysis of Thick Section Components Exposed at High Temperature in Power Plants.** Her, S.K. (Korea Electric Power Corp. (KEPCO), Taejon (Korea, Republic of). Research Center); Kim, K.Y.; Ha, J.S.; Back, S.K.; Kang, M.S.; Song, K.W.; Im, C.H.; Lee, J.S.; Hwang, C.K.; Lee, J.H.; Mung, N.S.; Hong, K.T.; Back, N.I.; Do, J.M.; Kim, S.C.; YooKorea Electric Power Corp. (KEPCO), Taejon (Korea, Republic of). Research Center. 1993. 425p. (In Korean). Order Number DE96703590. Source: OSTI; NTIS (US Sales Only).

Development for calculating method of the fracture mechanics parameters and their software, and the evaluation of their reliability . Crack propagation rate of the materials of the thick section components for the development of the software for the life prediction. Development of the software for life prediction and their application thick section components in Pyungtak and Ulsan power plant.

30292 (KRC–92H-J01) **A Study on the Operational Methods and Design of Earthquake Monitoring System for Kori Nuclear Unit 1.** Lee, J.R. (Korea Electric Power Corp. (KEPCO), Taejon (Korea, Republic of). Research Center); Lee, D.S.; Seo, Y.P.; Kim, I.K.; Lee, W.K.; Lee, S.W.; Chang, C.S.; Kim, S.T.; Choi, J.C.; Chang, S.P.; Ko, H.M.; Cho, Y.H.; Park, H.K.; Kim, M.Y.; Im, S.S.; Kim,Korea Electric Power Corp. (KEPCO), Taejon (Korea, Republic of). Research Center. 1993. 413p. (In Korean). Order Number DE96703595. Source: OSTI; NTIS (US Sales Only).

This study suggests the most effective seismic monitoring system for Kori Unit 1 which is compatible with the most up-to-date regulatory requirements and state-of-the-arts. The detailed technical requirements are also developed for the purchase, installation, operation and maintenance of the system. The existing seismic design data have been reviewed from the viewpoint of present regulation and the shortcomings have been reinforced by performing independent seismic re-analysis in order to be used as a reasonable comparison data with recorded earthquakes. In additions, a brief guideline for the response actions to an earthquake is provided. The guideline includes progressive responses of the operators and related engineers : immediate action, post-shutdown actions and ling-term actions. (author). 14 refs., fig.

30293 (KRC–93G-S05) **A Study on the Precise Diagnosis and Life Assessment for Aging Equipment of Thermal Power Plant.** Kim, G.Y. (Korea Electric Power Corp. (KEPCO), Taejon (Korea, Republic of). Research Center); Ha, J.S.; Back, S.K.; Kabg, M.S.; Song, K.W.; Kim, H.K.; Lee, K.H.; Choi, Y. Korea Electric Power Corp. (KEPCO), Taejon (Korea, Republic of). Research Center. 1994. 306p. (In Korean). Order Number DE96703582. Source: OSTI; NTIS (US Sales Only).

Improvement reliability and safety of long-served power plant (moreover served 25years) through precise diagnosis. Development technology of NDT to predict remnant life by detecting material degradation condition. Provide a basis for planing optimum replacement schedule. fig.

30294 (LA-UR–95-2127) **The relationship between neutron multiplication and k_{eff}.** Brewer, R.W. Los Alamos National Lab., NM (United States). [1995]. 10p. Sponsored by USDOE, Washington, DC (United States). DOE Contract W-7405-ENG-36. (CONF-9509100–19: 5. international conference on nuclear criticality safety, Albuquerque, NM (United States), 17-22 Sep 1995). Order Number DE95016869. Source: OSTI; NTIS; INIS; GPO Dep.

In recent years the International Criticality Safety Benchmark Evaluation Project under the sponsorship of the Department of Energy has undertaken the task of evaluating past critical experiments. Many of the experiments involving metals were subcritical with extrapolation to some critical characteristic dimension. The metal experiments were commonly limited to a maximum multiplication of 100 for obvious safety considerations. Also many critical experiments often used subcritical measurements to obtain the critical specifications, e.g. Jezebel used subcritical measurements to assess the magnitude of neutron reflection from the surrounding structures. Therefore, the task of evaluating the experimentally derived critical configuration often involves evaluating the subcritical measurements made by the experimentalist. The purpose of past experiments was to determine critical configurations. Many of the modern computer codes (KENO, MCNP, and ONEDANT) calculate values of k_{eff}. However, the subcritical measurements made during the course of the experiment are usually measurements of the neutron multiplication. To evaluate the subcritical experiments, a link was established between the neutronic theory and the practical application of such when using subcritical measurements to establish the critical characteristic dimension. A more in depth derivation of the relationship between k_{eff} and neutron multiplication will be shown along with comparisons between calculated and measured multiplications.

30295 (LA-UR–95-2322) **MC-1 generator performance with higher-energy explosives.** Sheppard, M.G. (and others); Brownell, J.H.; Christian, J.M. Los Alamos National Lab., NM (United States). [1995]. 7p. Sponsored by USDOE, Washington, DC (United States). DOE Contract AC08-93NV11265 ; W-7405-ENG-36. (EGG–11265-5040; CONF-950750–19: 10. Institute of

Electrical and Electronics Engineers (IEEE) pulsed power conference, Albuquerque, NM (United States), 10-13 Jul 1995). Order Number DE95016786. Source: OSTI; NTIS; GPO; GPO Dep.

The Russian designed MC-1 ultrahigh magnetic field generator was tested in 5 experiments as part of a joint US-Russian collaboration at Los Alamos National Laboratory in December of 1993. The standard Russian explosive 50150 RD was replaced with higher-energy-density US explosive, either COMP-B (60/40 RDX/TNT) or PBX-9501. Generator performance with COMP-B was nominally the same as reported for experiments with the slightly lower-energy Russian explosive. The Comp-B experiment produced a measured peak field of 9.4 megagauss. Using PBX-9501, the measured peak field increased to 10.9 megagauss with an appropriate increase in the time derivative of the field. One-dimensional MHD calculations with the Lagrangian code, RAVEN are compared with the experimental results.

30296 (LA-UR–95-2494) **Applications of LabVIEW programming in a glovebox environment.** Evans, M.E.; Peralta, G.; Gray, D. Los Alamos National Lab., NM (United States). [1995]. 15p. Sponsored by USDOE, Washington, DC (United States). DOE Contract W-7405-ENG-36. (CONF-9507148–4: 9. annual conference and equipment exhibit of the American Glovebox Society, Minneapolis, MN (United States), 19-25 Jul 1995). Order Number DE96000005. Source: OSTI; NTIS; INIS; GPO Dep.

When dealing with neutron radiation one of the keys to reducing worker exposure is to have as much distance and shielding between the radiation and the radiation worker as possible. Using a PC to control a process from a remote location allows the distance between the radiation worker and the radiation source to be increase. Increasing the distance at which radiation worker can control a process allows more shielding to be placed around the glovebox. There are many commercial packages that allow controlling remote processes with a PC. This paper shows how flexible the LabVIEW Graphical Programming Language can be in implementing the remote control of glovebox process.

30297 (LA-UR–95-2844) **Numerical analysis of deformation and surface generation in ultraprecision machining.** Anderson, C.A.; Stevens, R.R.; Rhorer, R.L. Los Alamos National Lab., NM (United States). [1995]. 15p. Sponsored by USDOE, Washington, DC (United States). DOE Contract W-7405-ENG-36. (CONF-951135–18: International mechanical engineering congress and exhibition - winter annual meeting of the American Society of Mechanical Engineers, San Francisco, CA (United States), 12-17 Nov 1995). Order Number DE96000014. Source: OSTI; NTIS; GPO Dep.

Approximate solutions from classical plasticity have in the past been used to describe the process of orthogonal machining. Recently, numerical methods using more complex constitutive models have provided more accurate data on the state of deformation near the tool tip and the generated new surface in a conventional machining process. In this study we have used a viscoplastic material model and an efficient finite element approach to examine the process of orthogonal ultraprecision machining. In contrast to previous numerical studies the cutting thickness to tool tip radius ratio is finite, which requires the use of highly refined finite clement meshes to produce accurate solutions. Results are presented showing the effects of tool edge geometry, material constants, the coefficient of friction, and depth of cut. The numerical results are compared with ultraprecision machining experiments on fine grain copper where thrust and cutting forces and the damaged region around the tool tip (whose profile was characterized by atomic force microscopy) were carefully measured as a function of the uncut chip thickness.

30298 (LA-UR–95-17922, pp. 902) **The current status and possible future of the Los Alamos spallation radiation effects facility.** Borden, M.J. (Los Alamos National Laboratory, NM (United States)); Sommer, W.F. Los Alamos National Lab., NM (United States). [1995]. (CONF-9407103–: International conference on accelerator-driven transmutation technologies and applications, Las Vegas, NV (United States), 25 Jul - 1 aug 1994). In *AIP conference on accelerator driven transmutation technologies and applications, Los Vegas, Nevada, July 25-29, 1994.* 958p. Order Number DE95014018. Source: OSTI; NTIS; INIS.

The Los Alamos Spallation Radiation Effects Facility (LASREF) has been configured for both proton and spallation neutron irradiations since 1985. The facility makes use of the Los Alamos Meson Physics Facility 1 mA 800 MeV proton beam. Environment controlled proton and neutron irradiations have been demonstrated over the past nine years. The current copper beam stop configuration produces a maximum measured neutron flux of 4.6×10^{17} $m^{-2}s^{-1}$ for energies greater than 1 KeV. The maximum proton flux at the center of Gaussian shaped beam is 1.2×10^{14} protons $cm^{-2}s^{-1}$ with beam spot diameter of 3.5 cm at 2σ. Previously published work has shown that the neutron flux can be increased by a factor of ten by changing the beam stop to tungsten and decreasing the diameter. Expertise exists at Los Alamos to further optimize this design to tailor neutron production and spectrum. Consideration and preliminary planning has also been done for increasing the LAMPF proton current from 1 mA to a few mA with a possible maximum of 10 mA. An upgrade of this type would produce current densities comparable to those proposed for the Accelerator-Driven Transmutation Technologies (ADTT) programs.

30299 (LBL–37032-Rev.) **Estimation of linear functionals in emission tomography.** Kuruc, A. Lawrence Berkeley Lab., CA (United States). Aug 1995. 57p. Sponsored by USDOE, Washington, DC (United States);Department of Health and Human Services, Washington, DC (United States). DOE Contract AC03-76SF00098. Order Number DE96000876. Source: OSTI; NTIS; GPO Dep.

In emission tomography, the spatial distribution of a radioactive tracer is estimated from a finite sample of externally-detected photons. We present an algorithm-independent theory of statistical accuracy attainable in emission tomography that makes minimal assumptions about the underlying image. Let f denote the tracer density as a function of position (i.e., f is the image being estimated). We consider the problem of estimating the linear functional $\Phi(f) \equiv \int \phi(x) f(x)\, dx$, where ϕ is a smooth function, from n independent observations identically distributed according to the Radon transform of f. Assuming only that f is bounded above and below away from 0, we construct statistically efficient estimators for $\Phi(f)$. By definition, the variance of the efficient estimator is a best-possible lower bound (depending on and f) on the variance of unbiased estimators of $\Phi(f)$. Our results show that, in general, the efficient estimator will have a smaller variance than the standard estimator based on the filtered-backprojection reconstruction algorithm. The improvement in performance is obtained by exploiting the range properties of the Radon transform.

30300 (LBL–37505) **Proboscis container shapes for the USML-2 interface configuration experiment.** Concus, P. (Univ. of California, Berkeley, CA (United States)); Finn, R.; Weislogel, M. Lawrence Berkeley Lab., CA (United States). May 1995. 8p. Sponsored by USDOE, Washington, DC (United States);National Science Foundation, Washington, DC (United States);National Aeronautics and Space Administration, Washington, DC (United States). DOE Contract AC03-76SF00098. (CONF-950576–1: 9. European symposium on gravity-dependent phenomena in physical sciences, Berlin (Germany), 2-5 May 1995). Order Number DE96001101. Source: OSTI; NTIS; GPO Dep.

Small changes in container shape or in contact angle can give rise to large shifts of liquid in a microgravity environment. Such behavior suggests a means for managing fluids in microgravity and, as one specific possible application, for the accurate determination of contact angle. In connection with this application, the authors discuss certain containers designed for the forthcoming USML-2 Glovebox Interface Configuration Experiment (ICE) and depict their behavior in preliminary drop tower experiments. The containers are in the form of a circular cylinder with two diametrically opposed "proboscis" protrusions. These shapes are based on the canonical (single) proboscis containers introduced mathematically, which have the properties in the absence of gravity that (i) fluid rises arbitrarily high over the entire proboscis for contact angles less than or equal to a critical value and (ii) the size of the proboscis can be made relatively as large a portion of the container cross section as desired. These properties allow overcoming some of the practical limitations of wedge containers; for the latter too little fluid may participate in the shift at a critical contact angle to be easily observable. The authors include some background material, where

computational results for the double proboscis containers are presented.

30301 (MLM–104) **Comments on handling of radioactive substances.** Staniforth, R.A. Mound Lab., Miamisburg, OH (United States). 17 May 1948. 5p. Sponsored by USDOE, Washington, DC (United States). DOE Contract AC04-76DP00053. Order Number DE96001399. Source: OSTI; NTIS; GPO Dep.

This brief report provides recommendations on handling of radioactive materials in the laboratory.

30302 (MLM–285) **Shielded room measurements, Final report.** Stanton, J.S. Mound Lab., Miamisburg, OH (United States). 22 Feb 1949. 23p. Sponsored by USDOE, Washington, DC (United States). DOE Contract AC04-76DP00053. Order Number DE96001396. Source: OSTI; NTIS; GPO Dep.

The attenuation of electro-statically and electro-magnetically shielded rooms in the "E," "R," "I," and "T" Buildings was measured so that corrective measure could be taken if the attenuation was found to be low. If remedial measures could not be taken, the shortcomings of the rooms would be known. Also, the men making the measurements should oversee construction and correct errors at the time. The work was performed by measuring the attenuation at spot frequencies over the range of from 150 kilocycles to 1280 megacycles with suitable equipment mounted in small rubber-tried trucks. The attenuation was determined by "before and after" shielding and/or "door open and door closed" measurements after installation of copper shielding. In general, attenuation in the frequency range of approximately 10 to 150 mc. was good and was of the order expected. At frequencies in the range of 150 mc. to 1280 mc., the attenuation curve was more erratic; that is, at certain frequencies a severe loss of attenuation was noted, while at others, the attenuation was very good. This was mainly due to poor or faulty seals around doors and pass windows. These poor seals existed in the "T," "E," and "I" Buildings because the doors were fitted improperly and somewhat inferior material was used. By experience from these difficulties, both causes were corrected in the "R" Building, which resulted in the improvement of the very high frequency (v.h.f.) range in this building. In some specific cases, however, the results were about the same. For the range of frequencies below approximately 10 mc., the attenuation, in almost all cases, gradually decreased as the frequency decreased and reached a minimum at .3 to 1.0 mc. This loss of attenuation was attributed to multiple grounding caused by moisture in the insulating timbers and will gradually decrease as the wood dries out.

30303 (MLM-MU–89-62-0003) **Construction project data sheet for the environmental, safety and health upgrades: Phase 3 Program FY 1991 line item.** Hunter, M.R. EG and G Mound Applied Technologies, Miamisburg, OH (United States). 3 Feb 1989. 14p. Sponsored by USDOE, Washington, DC (United States). DOE Contract AC24-88DP43495. Order Number DE96001395. Source: OSTI; NTIS; GPO Dep.

This document is prepared in tabular form and depicts costs and safety analysis of a number of Mound construction projects. Some projects described include solvent waste handling, environmental buffer zone, and sanitary treatment plant.

30304 (MLM-MU–89-64-0008) **Action description memorandum for the Facilities Capability Assurance Program (FCAP) FY 1992 FCAP Item: Steam and condensate system upgrades.** Adams, F.S.; Bauer, R.L.; Anderson, C.R. Mound, Miamisburg, OH (United States). Apr 1989. 5p. Sponsored by USDOE, Washington, DC (United States). DOE Contract AC24-88DP43495. Order Number DE96000800. Source: OSTI; NTIS; GPO Dep.

This ADM documents the evaluation of the potential environmental impact hazards from the Facilities Capability Assurance Project (FCAP), FY 1992, Line Item, Steam and Condensate Systems Upgrades.

30305 (MLM-MU–89-64-0013) **Design criteria for SW-205 capillary system.** Lyons, W.J. EG and G Mound Applied Technologies, Miamisburg, OH (United States). Apr 1989. 50p. Sponsored by USDOE, Washington, DC (United States). DOE Contract AC24-88DP43495. Order Number DE96000792. Source: OSTI; NTIS; GPO Dep.

This design criteria covers the converting of the SW-250 Capillary System from fumehood manual operation to sealed glovebox automated operation. The design criteria contains general guidelines and includes drawings reflecting a similar installation at another site. Topics include purpose and physical description, architectural-engineering requirements, reference document, electrical, fire protection, occupational safety and health, quality assurance, and security.

30306 (NREL/CP–433-7748, pp. 80-85) **Particle beam mass spectrometry of submicron particles sampled from low-pressure environments.** Ziemann, P.J. (Univ. of Minnesota, Minneapolis, MN (United States)); Liu, P.; Kittelson, D.B. National Renewable Energy Lab., Golden, CO (United States). Mar 1995. Contract SRC/MJ-225. (CONF-9410343–: Applications of free-jet, molecular beam, mass spectrometric sampling conference, Estes Park, CO (United States), 11-14 Oct 1994). In *Applications of free-jet, molecular beam, mass spectrometric sampling: Proceedings.* 305p. Order Number DE95004052. Source: OSTI; NTIS; GPO Dep.

The manufacture of semiconductor devices involves a variety of processes occurring over a wide range of operating pressures (from atmospheric to about 10^{-5} torr). During processing, particles can be produced by flaking from the walls of the equipment, or by homogeneous nucleation resulting from pump down or from reactions involving gas phase species that produce nonvolatile products. These particles can deposit on the surfaces of semiconductor devices, leading to defects which reduce product yield. It has been projected that by the year 2001 particles down to 15 nm, and perhaps as small as 5 nm, will be critical to the yield of 1 Gbit DRAMS. Semiconductor manufacturers will need to be able to detect aerosol particles down to these sizes at subatmospheric pressures, but there are currently no instruments available that can meet these requirements. Standard aerosol techniques for sizing and detecting particles are often limited to operation near atmospheric pressure (e.g. mobility analyzers, condensation nucleus counters), or cannot be used to detect low concentrations of ultrafine particles. In an effort to alleviate this problem, the authors have recently developed a particle beam mass spectrometer that can be used to size and detect ultrafine particles in low-pressure environments. The instrument can be used as a particle detector in process control, and as a tool for investigating particle formation in semiconductor equipment or other low-pressure systems. In this presentation they describe the operation of the instrument and the techniques used for calibration, data analysis, and measurements of particle size distributions. Size distributions measured using the particle beam mass spectrometer are compared with those obtained by differential mobility analysis, a standard technique for atmospheric pressure measurements. They also include some results from a recent investigation of particle formation during LPCVD of polysilicon films.

30307 (NREL/CP–433-7748, pp. 175-180) **Free-jet mass spectrometry of laser ablation plumes in thin film deposition.** Hastie, J.W. (National Institute of Stanfords and Technology, Gaithersburg, MD (United States)); Paul, A.J.; Bonnell, D.W. National Renewable Energy Lab., Golden, CO (United States). Mar 1995. (CONF-9410343–: Applications of free-jet, molecular beam, mass spectrometric sampling conference, Estes Park, CO (United States), 11-14 Oct 1994). In *Applications of free-jet, molecular beam, mass spectrometric sampling: Proceedings.* 305p. Order Number DE95004052. Source: OSTI; NTIS; GPO Dep.

Plumes generated by high-power pulsed (10-30 ns) laser vaporization or ablation of refractory materials can attain ultra-high temperatures (5,000-30,000 K) and relatively high pressures (> 1 bar). However, plume expansion into a vacuum is sufficiently rapid that the initial species information can be retained and representative sampling with molecular beam mass spectrometry (MBMS) can be achieved. In order to verify and supplement the MBMS results, complementary investigations using emission spectroscopy and real-time imaging, coupled with gasdynamic, thermodynamic, and gaskinetic models are also carried out. In addition to plume species identities and abundances, MBMS analysis also provides beam time-of-flight information, yielding velocity distributions and gas temperatures. MBMS applications are considered here for systems important in thin film processing, such as Al_2O_3 and C.

Attention is also given to the essential features required of a free-jet MBMS system for representative sampling of laser ablation plumes. Significant progress in defining the general nature of laser vaporization/ablation plumes, used for thin film deposition, has been made in recent years. The authors current understanding of the main plume features are summarized by the idealized schematic. The plume initiates at the laser focus spot on the target surface and moves away along an axis normal to the target. After a few ns time delay from the onset of the laser pulse, sufficient vapor density develops for collisional local equilibrium to become established, followed by a supersonic adiabatic expansion process. This expansion process is isentropic and rapidly leads to a free-flight, collision-free condition. In the present work, species are sampled from this free-flight region for MBMS analysis.

30308 Split driveshaft pump for hazardous fluids. Evans, T.P II; Purohit, J.J.; Fazio, J.M. 1993. Filed date 11 Jun 1993. U.S. Patent Application 8-075,900. 15p. Sponsored by USDOE, Washington, DC (United States). DOE Contract AC09-89SR18035. Order Number DE95017109. Source: OSTI; NTIS (US Sales Only); GPO Dep.

A pump having a split driveshaft for use in pumping hazardous fluids is disclosed wherein only one driveshaft becomes contaminated by the fluid while the second remains isolated from the fluid. The pump has a first portion and a second portion. The first portion contains a pump motor, the first driveshaft, a support pedestal, and vapor barriers and seals. The second portion contains a second, self-lubricating driveshaft and an impeller. The first and second driveshafts are connected together by a releasable coupling. A shield and a slinger deployed below the coupling prevent fluid from the second portion from reaching the first portion. In operation, only the second assembly comes into contact with the fluid being pumped, so the risk of contamination of the first portion by the hazardous fluid is reduced. The first can be removed for repairs or routine maintenance by decoupling the first and second driveshafts and disconnecting the motor from the casing.

30309 (PNL–10757) **Structural vibration control of micro/macro-manipulator using feedforward and feedback approaches.** Lew, J.Y. (Pacific Northwest Lab., Richland, WA (United States)); Cannon, D.W.; Magee, D.P.; Book, W.J. Pacific Northwest Lab., Richland, WA (United States). Sep 1995. 25p. Sponsored by USDOE, Washington, DC (United States). DOE Contract AC06-76RL01830. Order Number DE96001341. Source: OSTI; NTIS; INIS; GPO Dep.

Pacific Northwest Laboratory (PDL) researchers investigated the combined use of two control approaches to minimize micro/macro-manipulator structural vibration: (1) modified input shaping and (2) inertial force active damping control. Modified input shaping (MIS) is used as a feedforward controller to modify reference input by canceling the vibratory motion. Inertial force active damping (IFAD) is applied as a feedback controller to increase the system damping and robustness to unexpected disturbances. Researchers implemented both control schemes in the PNL micro/macro flexible-link manipulator testbed collaborating with Georgia Institute of Technology. The experiments successfully demonstrated the effectiveness of two control approaches in reducing structural vibration. Based on the results of the experiments, the combined use of two controllers is recommended for a micro/macro manipulator to achieve the fastest response to commands while canceling disturbances from unexpected forces.

30310 (POEF-SH–34) **Verification of criticality accident alarm system detector locations for the X-326 process cell floor.** Dobelbower, M.C. (Battelle, Columbus, OH (United States)); Woollard, J.; Lee, B.L. Jr.; Tayloe, R.W. Jr. Lockheed Martin Utility Services, Inc., Oak Ridge, TN (United States); Portsmouth Gaseous Diffusion Plant, OH (United States). Aug 1995. 70p. Sponsored by USDOE, Washington, DC (United States). DOE Contract AC05-76OR00001. Order Number DE95017168. Source: OSTI; NTIS; INIS; GPO Dep.

Criticality Accident Alarm System (CAAS) detectors on the cell floor of the X-326 process building at the Portsmouth Gaseous Diffusion Plant (PORTS) are located at a height of 5 m above the cell floor. It has been suggested that this height be lowered to I m to alleviate accelerated system failures caused by the elevated temperatures at 5 m and to reduce the frequency of injury to maintenance personnel lifting the approximately 90-lb units into position. Work has been performed which analyzed the effect of relocating the CAAS detectors on the process floors of the X-333 and X-330 buildings from their current height to a height of 1 m^1. This earlier work was based on criticality accidents occurring in low enriched material (5% ^{235}U) and was limited to the X-333 and X-330 buildings and the low enriched areas of X-326. It did not consider the residual higher enriched material in the X-326 building. This report analyzes the effect on criticality alarm coverage of lowering the CAAS detectors. This analysis is based on criticality accidents resulting from higher enriched material which may be present as "hold-up" in the process equipment within the X-326 building. The criticality accident alarm detectors at the PORTS facility are set to alarm at a neutron absorbed dose rate of 5 mrad/hr. The calculated absorbed dose rates presented in this report show that the detectors examined that produce an alarm for the given criticality event at their current height will also produce an alarm if located at a height of 1 meter. Therefore, lowering the detectors will not result in a loss of coverage within the building.

30311 (PPPL-CFP–3349) **The operation of the Tokamak Fusion Test Reactor Tritium Facility.** Gentile, C.A. (Princeton Univ., NJ (United States). Plasma Physics Lab.); LaMarche, P.H.; Anderson, J.L. Princeton Univ., NJ (United States). Plasma Physics Lab. [1995]. 3p. Sponsored by USDOE, Washington, DC (United States). DOE Contract AC02-76CH03073. (CONF-950506–16: 5. topical meeting on tritium technology in fission, fusion and isotopic applications, Ispra (Italy), 28 May - 3 jun 1995). Order Number DE95014765. Source: OSTI; NTIS; INIS; GPO Dep.

The TFTR tritium operations staff has successfully received, stored, handled, and processed over five hundred thousand curies of tritium for the purpose of supporting D-T (Deuterium-Tritium) operations at TFTR. Tritium operations personnel nominally provide continuous round the clock coverage (24 hours/day, 7 days/week) in shift complements consisting of I supervisor and 3 operators. Tritium Shift Supervisors and operators are required to have 5 years of operational experience in either the nuclear or chemical industry and to become certified for their positions. The certification program provides formal instruction, as well as on the job training. The certification process requires 4 to 6 months to complete, which includes an oral board lasting up to 4 hours at which time the candidate is tested on their knowledge of Tritium Technology and TFTR Tritium systems. Once an operator is certified, the training process continues with scheduled training weeks occurring once every 5 weeks. During D-T operations at TFTR the operators must evacuate the tritium area due to direct radiation from TFTR D-T pulses. During " time operators maintain cognizance over tritium systems via a real time TV camera system. Operators are able to gain access to the Tritium area between TFTR D-T pulses, but have been excluded from die tritium area during D-T pulsing for periods up to 30 minutes. Tritium operators are responsible for delivering tritium gas to TFRR as well as processing plasma exhaust gases which lead to the deposition of tritium oxide on disposable molecular sieve beds (DMSB). Once a DMSB is loaded, the operations staff remove the expended DMSB, and replace it with a new DMSB container. The TFIR tritium system is operated via detailed procedures which require operator sign off for system manipulation. There are >300 procedures controlling the operation of the tritium systems.

30312 (SAND–94-2268C) **Application of Latin hypercube sampling to RADTRAN 4 truck accident risk sensitivity analysis.** Mills, G.S.; Neuhauser, K.S.; Kanipe, F.L. Sandia National Labs., Albuquerque, NM (United States). [1994]. 13p. Sponsored by USDOE, Washington, DC (United States). DOE Contract AC04-94AL85000. (CONF-951203–1: 11. international conference on packaging and transportation of radioactive materials, Las Vegas, NV (United States), 3-8 Dec 1995). Order Number DE95006817. Source: OSTI; NTIS; INIS; GPO Dep.

The sensitivity of calculated dose estimates to various RADTRAN 4 inputs is an available output for incident-free analysis because the defining equations are linear and sensitivity to each variable can be calculated in closed mathematical form. However, the necessary linearity is not characteristic of the equations used in calculation of accident dose risk, making a similar tabulation of

sensitivity for RADTRAN 4 accident analysis impossible. Therefore, a study of sensitivity of accident risk results to variation of input parameters was performed using representative routes, isotopic inventories, and packagings. It was determined that, of the approximately two dozen RADTRAN 4 input parameters pertinent to accident analysis, only a subset of five or six has significant influence on typical analyses or is subject to random uncertainties. These five or six variables were selected as candidates for Latin Hypercube Sampling applications. To make the effect of input uncertainties on calculated accident risk more explicit, distributions and limits were determined for two variables which had approximately proportional effects on calculated doses: Pasquill Category probability (PSPROB) and link population density (LPOPD). These distributions and limits were used as input parameters to Sandia's Latin Hypercube Sampling code to generate 50 sets of RADTRAN 4 input parameters used together with point estimates of other necessary inputs to calculate 50 observations of estimated accident dose risk.Tabulations of the RADTRAN 4 accident risk input variables and their influence on output plus illustrative examples of the LHS calculations, for truck transport situations that are typical of past experience, will be presented

30313 (SAND–95-1149C) **A comparison of LBW and GTAW processes in miniature closure welds.** Knorovsky, G.A.; Fuerschbach, P.W.; Gianoulakis, S.E.; Burchett, S.N. Sandia National Labs., Albuquerque, NM (United States). [1995]. 7p. Sponsored by USDOE, Washington, DC (United States). DOE Contract AC04-94AL85000. (CONF-950682–2: 4. international conference on trends in welding research, Gatlinburg, TN (United States), 5-9 Jun 1995). Order Number DE95015084. Source: OSTI; NTIS; GPO Dep.

When small electronic components with glass-to-metal seals are closure welded, residual stresses developed in the glass are of concern. If these stresses exceed allowable tensile levels' the resulting weld-induced seal failure may cause the entire component to be scrapped or reworked at substantial cost. Conventional wisdom says the best welding process for these applications is that which provides the least heat input, and that Laser Beam Welding (LBW) provides less heat input than Gas Tungsten Arc Welding. (GTAW); however, other concerns such as weld fit-up, part variability, and material weldability can modify the final choice of a welding process. In this paper we compare the characteristic levels of heat input and the residual stresses generated in the glass seals for the two processes (as calculated by 3D Finite Element Analysis) as a function of heat input and travel speed, and contrast some of the other manufacturing decisions that must be made to choose a production process. The geometry chosen is a standing edge corner weld in a cylindrical container about 20 mm diameter by 35 mm tall. Four metal pins are glassed into the part lid. The stresses calculated to result from continuous wave CO_2 LBW are compared with those that result from GTAW. The total energy required by the laser weld is significantly less than for the equivalent size GTA weld. The energy input required for a given size weld is inversely proportional to the travel speed, but approaches a saturation level as the travel speed increases. LBW travel speeds ranging from 10 mm/sec to 50 mm/sec were examined.

30314 (SAND–95-1551/2) **1994 Triggered lightning test program: Measured responses of a reinforced concrete building under direct lightning attachments, Volume 2: Test data.** Schnetzer, G.H. (and others); Chael, J.; Davis, R. Sandia National Labs., Albuquerque, NM (United States). Aug 1995. 541p. Sponsored by USDOE, Washington, DC (United States). DOE Contract AC04-94AL85000. Order Number DE95017581. Source: OSTI; NTIS; GPO Dep.

A rocket-triggered lightning test was carried out during the summer of 1994 on a specially designed steel reinforced concrete test building located at Ft. McClellan, Alabama. Currents, voltages, and magnetic fields were measured at 24 instrumented locations during 42 return strokes triggered to designated points on the structure and its lightning protection system. Detailed descriptions of the test structure, measurements, and test procedures are given in Volume 1 of this report. The present volume contains plots of the complete set of test data.

30315 (SAND–95-1635C) **Wind-induced interaction of a large cylindrical calorimeter and an engulfing JP-8 pool fire.** Gritzo, L.A.; Nicolette, V.F.; Murray, D.; Moya, J.L.; Skocypec, R.D. Sandia National Labs., Albuquerque, NM (United States). [1995]. 6p. Sponsored by USDOE, Washington, DC (United States). DOE Contract AC04-94AL85000. (CONF-951135–13: International mechanical engineering congress and exhibition - winter annual meeting of the American Society of Mechanical Engineers, San Francisco, CA (United States), 12-17 Nov 1995). Order Number DE95015851. Source: OSTI; NTIS; GPO Dep.

As part of a research program in fire science and technology at Sandia National Laboratories (SNL), an experimental and computational investigation of the fire phenomenology associated with the presence of a large (3.66 m diameter), fuselage-sized cylindrical calorimeter engulfed in a large (18.9 m diameter) JP-8 pool fire subjected to high (10.2 m/s) winds were performed. The conditions investigated here resulted in a twofold increase in the incident heat flux to the surface of the object relative to heat fluxes typical of large hydrocarbon fires without engulfed objects. Due to the enhanced fuel/air mixing, enhanced turbulence, and larger flame volume, the highest heat fluxes are observed on the leeward side of the calorimeter. Radiative heat fluxes of 150–250 kW/m^2 on this side, with the maximum heat flux occurring near the top of the calorimeter, were measured. Radiative heat fluxes of 60–200 kW/m^2 were measured on the windward side, with the highest heat flux near the bottom of the calorimeter. Measured and predicted heat fluxes to the pool surface of 25–90 kW/m^2 were observed. The presence of the calorimeter tends to decrease the overall fuel consumption rate primarily due to redirection of the flame zone away from the pool surface. Overall, the numerical models does a reasonable job of representing the essential features of the fire environment but under predicts the heat flux to the calorimeter. These results emphasize the importance of considering the wind-induced interaction of fires and large objects when estimating the incident heat fluxes on a engulfed object. The measurements and analyses are of particular interest since few studies to date have addressed cases where the fire and object are of comparable size.

30316 (UCRL-ID–121163) **Nuclear criticality safety evaluation of large cylinder cleaning operations in X-705, Portsmouth Gaseous diffusion Plant.** Sheaffer, M.K.; Keeton, S.C.; Lutz, H.F. Lawrence Livermore National Lab., CA (United States). Jun 1995. 43p. Sponsored by USDOE, Washington, DC (United States). DOE Contract W-7405-ENG-48. Order Number DE96001009. Source: OSTI; NTIS; INIS; GPO Dep.

This report evaluates nuclear criticality safety for large cylinder cleaning operations in the Decontamination and Recovery Facility, X-705, at the Portsmouth Gaseous Diffusion Plant. A general description of current cleaning procedures and required hardware/equipment is presented, and documentation for large cylinder cleaning operations is identified and described. Control parameters, design features, administrative controls, and safety systems relevant to nuclear criticality are discussed individually, followed by an overall assessment based on the Double Contingency Principle. Recommendations for enhanced safety are suggested, and issues for increased efficiency are presented.

30317 (UCRL-ID–121679) **Closed-form approach to checking frame design.** Blake, A. Lawrence Livermore National Lab., CA (United States). 5 Apr 1995. 46p. Sponsored by USDOE, Washington, DC (United States). DOE Contract W-7405-ENG-48. Order Number DE96001024. Source: OSTI; NTIS; GPO Dep.

This brief report contains calculations of deflections and stresses of the support frame on the XMM project. The goal is to provide an independent view of structural integrity of the frame utilizing a non-computer approach to design based on elementary closed form solutions and approximate models of mechanical and structural behavior. It is recognized that full confidence can only be assured when computer generated results pertaining to the critical areas and features of the integrating structure can be enveloped by the bracketing solutions. Although the computer solutions have come from the three independent sources, this report utilizes the numerical values from the LLNL studies represented by the computer runs and analysis of the critical elements of the frame. Since the frame geometry, deformation patterns, and the nature of loading

are highly complex, this study is restricted to simplified models of selected areas of the structure which can be handled by the conventional formulas and reasonable approximations. This report contains some comments related to material properties, stress concentration, and elements of fracture mechanics directly applicable to frame analysis and design. Such topics and parameters fall usually outside the finite element modeling, but they can have a crucial influence on the mechanical and structural performance of the systems at hand.

30318 (UCRL-JC–117078-Rev.1) **Computational model of drilling with high radiance pulsed lasers. Revision 1.** Boley, C.D.; Early, J.T. Lawrence Livermore National Lab., CA (United States). 12 Oct 1994. 10p. Sponsored by USDOE, Washington, DC (United States). DOE Contract W-7405-ENG-48. (CONF-9410189–1-Rev.1: Applications of lasers and electro-optics, Orlando, FL (United States), 17-20 Oct 1994). Order Number DE95011751. Source: OSTI; NTIS; GPO Dep.

A model of drilling by high radiance pulsed lasers is described. The model involves a one-dimensional description of heat transport below the bottom of the hole, hydrodynamic expansion of the vapor and compressed air, and light propagation through the vapor. The pressure and energy of the vapor are taken from a separate Saha equilibrium code. The boundary conditions at the vaporization surface include the formation of a transition layer within which macroscopic fluid conditions axe reached. The absorption mechanisms are photoionization and inverse bremsstrahlung. The model has been applied to the case of drilling in stainless steel with green copper laser light, for peak input intensities ranging from 10^8 to 4 $\times$ 10^{10} W/cm^2. Below 3 $\times$ 10^8 W/cm^2, there is negligible absorption in the vapor and ablation increases rapidly with intensity. After decreasing for a short interval beyond this point, the ablation rate then increases steadily with power because of a growing electron thermal conduction to the surface. The experimental ablation rate exhibits a somewhat faster overall growth. It appears comparable to the model at low power but is about five times greater at the highest power.

30319 (UCRL-JC–120350) **Criticality concerns in cleaning large uranium hexafluoride cylinders.** Sheaffer, M.K.; Keeton, S.C.; Lutz, H.F. Lawrence Livermore National Lab., CA (United States). Jun 1995. 8p. Sponsored by USDOE, Washington, DC (United States). DOE Contract W-7405-ENG-48. (CONF-9509100–30: 5. international conference on nuclear criticality safety, Albuquerque, NM (United States), 17-22 Sep 1995). Order Number DE96001749. Source: OSTI; NTIS; INIS; GPO Dep.

Cleaning large cylinders used to transport low-enriched uranium hexafluoride (UF_6) presents several challenges to nuclear criticality safety. This paper presents a brief overview of the cleaning process, the criticality controls typically employed and their bases. Potential shortfalls in implementing these controls are highlighted, and a simple example to illustrate the difficulties in complying with the Double Contingency Principle is discussed. Finally, a summary of recommended criticality controls for large cylinder cleaning operations is presented.

30320 (UCRL-JC–120535) **Natural phenomena hazards assessment criteria for DOE sites: DOE Standard DOE-STD-1023-95.** Chen, J.C. (and others); Lu, S.C.; Boissonnade, A.C. Lawrence Livermore National Lab., CA (United States). 24 Mar 1995. 13p. Sponsored by USDOE, Washington, DC (United States). DOE Contract W-7405-ENG-48. (CONF-950740–95: Joint ASME/JSME pressure vessels and piping conference, Honolulu, HI (United States), 23-27 Jul 1995). Order Number DE96000087. Source: OSTI; NTIS; GPO Dep.

This paper summarizes hazard assessment criteria (DOE-STD-1023-95) for Natural Phenomena Hazards (NPH) at DOE sites. The DOE has established policy and requirements for NPH mitigation for DOE sites and facilities using a graded approach by DOE Order 5480.28. The graded approach is implemented by five performance categories established for structures, systems, and components (SSCs) at DOE facilities based on criteria provided by DOE-STD-1021-93. In applying the design/evaluation criteria of DOE-STD-1020-94 for DOE facilities subjected to one of the natural phenomena hazards, the establishment of design basis load levels consistent with the corresponding performance category is required. This standard provides general criteria as well as specific criteria for natural phenomena hazard assessments to ensure that adequate design basis load levels are established for design and/or evaluation of DOE facilities.

30321 (UCRL-JC–120907) **Safety aspects with regard to plutonium vitrification techniques.** Gray, L.W.; Kan, T. Lawrence Livermore National Lab., CA (United States). 11 May 1995. 12p. Sponsored by USDOE, Washington, DC (United States). DOE Contract W-7405-ENG-48. (CONF-9505238–4: NATO international scientific exchange program advanced research workshop, St. Petersburg (Russian Federation), 14-17 May 1995). Order Number DE96000378. Source: OSTI; NTIS; INIS; GPO Dep.

Substantial inventories of excess plutonium are expected to result from dismantling US and Russian nuclear weapons. Disposition of this material should be a high priority in both countries. Various disposition options are under consideration. One option is to vitrify the plutonium with the addition of ^{137}Cs or high-level waste to act as a deterrent to proliferation. The primary safety problem associated with vitrification of plutonium is to avoid criticality in form fabrication and in the final repository over geologic time. Recovery should be as difficult (costly) as the recovery of plutonium from spent fuel.

30322 (UCRL-JC–121076) **Recommended strategy for fabrication of radioactive material transport packagings to the requirements of the ASME boiler and pressure vessel code (B&PVC) Section 3, utilizing B&PVC Section 3 certified fabricators.** Russell, E.W.; Dann, R.K.; Chinn, D.J. Lawrence Livermore National Lab., CA (United States). Apr 1995. 6p. Sponsored by USDOE, Washington, DC (United States). DOE Contract W-7405-ENG-48. (CONF-950740–92: Joint ASME/JSME pressure vessels and piping conference, Honolulu, HI (United States), 23-27 Jul 1995). Order Number DE95017298. Source: OSTI; NTIS; GPO Dep.

This document provides guidance on the implementation of the requirements of the ASME B&PVC Section III, that may be applied to the acquisition of new packagings that will be used in the transportation of radioactive material, to be licensed by the DOE Transportation and Packaging Safety Division. This guidance is relevant to the manufacture of components that must meet the requirements of the B&PVC Section III and involves defining the additional requirements for fabrication and QA for an ASME nonnuclear certified fabrication facility. Survey information has been provided that illustrates that the number and geographic distribution of ASME nuclear (N-stamp) certified facilities may not necessarily be advantageous for the applicant acquiring production packagings in a timely and economic manner. The fabrication requirements of the B&PVC Section III that exceed those of Section VIII are summarized for base metals, welding materials, weld joint preparation, welding, heat treatment, forming, qualification of welding, heat treatment, forming, qualification of welding procedures and personnel, weld nondestructive examination and fracture toughness. An organization considering this type of acquisition must conduct an overall economic analysis to determine the cost and delivery for an ASME N-stamp facility as well as for an ASME non-nuclear certified facility that is supplementing its program as described in this paper. This must be done on a case-by-case basis.

30323 (UCRL-JC–121130) **Ablative material removal utilizing the copper vapor laser.** Warner, B.E.; Boley, C.D.; Chang, J.J.; Dragon, E.P.; Havstad, M.A.; Martinez, M.; McLean, W. II. Lawrence Livermore National Lab., CA (United States). Aug 1995. 4p. Sponsored by USDOE, Washington, DC (United States). DOE Contract W-7405-ENG-48. (CONF-9510193–3: LEOS '95: Institute of Electrical and Electronics Engineers Lasers and Electro-Optics Society annual meeting, San Francisco, CA (United States), 30 Oct - 2 nov 1995). Order Number DE96000342. Source: OSTI; NTIS; INIS; GPO Dep.

Short communication. METAL VAPOR LASERS/uses; USES; ABLATION; LASER DRILLING; DEPOSITION; REMOVAL

30324 (UCRL-JC–121331) **Frequency response characteristics and response spectra of base-isolated and un-isolated structures.** Mok, G.C. (Lawrence Livermore National Lab., CA (United States)); Namba, H. Lawrence Livermore National Lab., CA

(United States). 6 Jul 1995. 20p. Sponsored by USDOE, Washington, DC (United States). DOE Contract W-7405-ENG-48. (CONF-950740–93: Joint ASME/JSME pressure vessels and piping conference, Honolulu, HI (United States), 23-27 Jul 1995). Order Number DE95017822. Source: OSTI; NTIS; GPO Dep.

The transmissibility of seismic loads through a linear base-isolation system is analyzed using an impedance method. The results show that the system acts like a "low-pass" filter. It attenuates high-frequency loads but passes through low-frequency ones. The filtering effect depends on the vibration frequencies and damping of the isolated structure and the isolation system. This paper demonstrates the benefits and design principles of base isolation by comparing the transmissibilities and response spectra of isolated and un-isolated structures. Parameters of typical isolated buildings and ground motions of the 1994 Northridge earthquake are used for the demonstration.

30325 (UCRL-JC–121345-Pt.1) **Seismic shock and vibration isolation 1995. Part I: Theory, analysis, and testing.** Mok, G.C. (Lawrence Livermore National Lab., CA (United States)); Chung, H.H. Lawrence Livermore National Lab., CA (United States). 11 Jul 1995. 7p. Sponsored by USDOE, Washington, DC (United States). DOE Contract W-7405-ENG-48. (CONF-950740–94-Pt.1: Joint ASME/JSME pressure vessels and piping conference, Honolulu, HI (United States), 23-27 Jul 1995). Order Number DE95017818. Source: OSTI; NTIS; GPO Dep.

Two basic engineering strategies for the protection of equipment and structures from damages caused by seismic shock and vibration loadings are, namely, strengthening and isolation. They work on almost totally different principles; the strengthening strategy aims primarily at increasing the capacity or the ability of the structure to withstand the dynamic loading by incorporating additional structural materials and components, while the isolation strategy focuses on reducing the demand or the transmitted loading on the structure by adding an isolator or isolation system between the structure and the source of the loading. The isolation strategy is often used for filtering out unwanted vibrations and noises. In practice, the isolation strategy has the advantage of not depending on alterations to the isolated structure and is often the preferred method for applications in equipment and in some structures.

30326 (UCRL-JC–121501) **Multimodal interfaces with voice and gesture input.** Milota, A.D.; Blattner, M.M. Lawrence Livermore National Lab., CA (United States). 20 Jul 1995. 8p. Sponsored by National Science Foundation, Washington, DC (United States);Texas Univ., Austin, TX (United States). DOE Contract W-7405-ENG-48. Grant IRI-9213823. (CONF-9510197–1: Institute of Electrical and Electronics Engineers international conference on systems, man and cybernetics, Vancouver (Canada), 22-25 Oct 1995). Order Number DE95015989. Source: OSTI; NTIS; GPO Dep.

The modalities of speech and gesture have different strengths and weaknesses, but combined they create synergy where each modality corrects the weaknesses of the other. We believe that a multimodal system such a one interwining speech and gesture must start from a different foundation than ones which are based solely on pen input. In order to provide a basis for the design of a speech and gesture system, we have examined the research in other disciplines such as anthropology and linguistics. The result of this investigation was a taxonomy that gave us material for the incorporation of gestures whose meanings are largely transparent to the users. This study describes the taxonomy and gives examples of applications to pen input systems.

30327 (UCRL-JC–121619) **Performance of laser guide star adaptive optics at Lick Observatory.** Olivier, S.S. (and others); An, J.; Avicola, K. Lawrence Livermore National Lab., CA (United States). 19 Jul 1995. 10p. Sponsored by USDOE, Washington, DC (United States). DOE Contract W-7405-ENG-48. (CONF-950793–48: 40. annual meeting of the Society of Photo-Optical Instrumentation Engineers, San Diego, CA (United States), 9-14 Jul 1995). Order Number DE95017869. Source: OSTI; NTIS; GPO Dep.

A sodium-layer laser guide star adaptive optics system has been developed at Lawrence Livermore National Laboratory (LLNL) for use on the 3-meter Shane telescope at Lick Observatory. The system is based on a 127-actuator continuous-surface deformable mirror, a Hartmann wavefront sensor equipped with a fast-framing low-noise CCD camera, and a pulsed solid-state-pumped dye laser tuned to the atomic sodium resonance line at 589 nm. The adaptive optics system has been tested on the Shane telescope using natural reference stars yielding up to a factor of 12 increase in image peak intensity and a factor of 6.5 reduction in image full width at half maximum (FWHM). The results are consistent with theoretical expectations. The laser guide star system has been installed and operated on the Shane telescope yielding a beam with 22 W average power at 589 nm. Based on experimental data, this laser should generate an 8th magnitude guide star at this site, and the integrated laser guide star adaptive optics system should produce images with Strehl ratios of 0.4 at 2.2 μm in median seeing and 0.7 at 2.2 μm in good seeing.

30328 (UCRL-JC–121657) **The NASA B-757 HIRF test series: Low power on-the-ground tests.** Poggio, A.J. (Lawrence Livermore National Lab., CA (United States)); Zacharias, R.A.; Pennock, S.T.; Avalle, C.A.; Carney, H. Lawrence Livermore National Lab., CA (United States). Jul 1995. 9p. Sponsored by USDOE, Washington, DC (United States). DOE Contract W-7405-ENG-48. (CONF-9511126–1: 14. digital avionics systems conference, Boston, MA (United States), 5-9 Nov 1995). Order Number DE95017823. Source: OSTI; NTIS; GPO Dep.

The data acquisition phase of a program intended to provide data for the validation of computational, analytical and experimental for the assessment of electromagnetic effects i n transports, for the checkout of instrumentation for following test programs, and for the support of protection engineering of airborne systems has been completed. Funded by the NASA Fly-By-Light/Power-By-Wire Program, the initial phase involved on-the-ground electromagnetic measurements using the NASA Boeing 757 and was executed in the LESLI Facility at the USAF Phillips Laboratory. The major participants were LLNL, NASA Langley Research Center, Phillips Laboratory, and UIE, Inc. Measurements were made of the fields coupled into the aircraft interior and signals induced in select structures and equipment under controlled illumination by RF fields. A characterization of the ground was also performed to permit ground effects to be included in forthcoming validation exercises. A series of fly-by experiments were conducted in early 1995 in which the NASA B-757 was flown in the vicinity of a Voice of America station (~25 MHz), a fixed transmitter driving an LP array (172 MHz), and an ASRF radar at Wallops Island (430 MHz). In this paper, the overall test program is defined with particular attention to the on-the-ground portion. It is described in detail with presentation of the test rationale, test layout, and samples of the data. Samples of some inferences from the data that will be useful in protection engineering and EM effects mitigation will also be presented.

30329 (WHC-SP–1138-Rev.1) **Engineering testing and technology projects FY 1996 Site Support Program Plan, WBS 6.3.3 and 6.3.8. Revision 1.** Brown, L.C. Westinghouse Hanford Co., Richland, WA (United States). Oct 1995. 70p. Sponsored by USDOE, Washington, DC (United States). DOE Contract AC06-87RL10930. Order Number DE96001631. Source: OSTI; NTIS; INIS; GPO Dep.

The engineering laboratory services for development, assembly, testing, and evaluation to support the resolution of WHC, Hanford, and DOE complex wide engineering issues for 1996 are presented. Primary customers are: TWRS, spent nuclear fuels, transition projects, liquid effluent program, and other Hanford contractors and programs. Products and services provided include: fabrication and assembly facilities for prototype and test equipment, development testing, proof of principle testing, instrumentation testing, nondestructive examination application development and testing, prototype equipment design and assembly, chemical engineering unit operations testing, engineering test system disposal, and safety issue resolution.

30330 (WSRC-MS–95-0386) **Robotics and Automation Activities at the Savannah River Site: A Site Report for SUBWOG 39F.** Teese, G.D. Westinghouse Savannah River Co., Aiken, SC

(United States). 28 Sep 1995. 9p. Sponsored by USDOE, Washington, DC (United States). DOE Contract AC09-89SR18035. Order Number DE96060017. Source: OSTI; NTIS; INIS; GPO Dep.

The Savannah River Site has successfully used robots, teleoperators, and remote video to reduce exposure to ionizing radiation, improve worker safety, and improve the quality of operations. Previous reports have described the use of mobile teleoperators in coping with a high level liquid waste spill, the removal of highly contaminated equipment, and the inspection of nuclear reactor vessels. This report will cover recent applications at the Savannah River, as well as systems which SRS has delivered to other DOE site customers.

30331 (Y/AMT–157) **Centers for manufacturing technology: Industrial Advisory Committee Review.** Oak Ridge National Lab., TN (United States). [1995]. 250p. Sponsored by USDOE, Washington, DC (United States). DOE Contract AC05-84OR21400. Order Number DE96000446. Source: OSTI; NTIS; GPO Dep.

An advisory committee, composed of senior managers form industrial- sector companies and major manufacturing trade associations and representatives from appropriate educational institutions, meets semi-annually to review and advise the Oak Ridge Centers for Manufacturing Technology (ORCMT) on its economic security program. Individual papers have been indexed separately for the database.

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Refer also to citation(s) 29451, 29504, 29512, 29612, 29613, 29614, 29615, 29616, 29617, 29618, 29619, 29620, 29621, 29622, 29626, 29628, 29630, 29631, 29632, 29633, 29634, 29637, 29638, 29639, 29640, 29642, 29650, 29651, 29665, 29685, 29696, 29699, 29701, 29702, 29703, 29704, 29705, 29706, 29707, 29708, 29709, 29710, 29711, 29712, 29713, 29714, 29715, 29716, 29717, 29718, 29719, 29720, 29721, 29722, 29723, 29724, 29726, 29727, 29728, 29729, 29730, 29731, 29732, 29733, 29734, 29735, 29736, 29737, 29738, 29739, 29740, 29741, 29742, 29743, 29744, 29745, 29746, 29747, 29748, 29749, 29750, 30079, 30749, 31320, 31321, 31332, 31336, 31379

30332 (ANL/ET/CP–84666) **A chaotic system of two-phase flow in a small, horizontal, rectangular channel.** Cai, Y.; Wambsganss, M.W.; Jendrzejczyk, J.A. Argonne National Lab., IL (United States). [1995]. 24p. Sponsored by USDOE, Washington, DC (United States). DOE Contract W-31-109-ENG-38. (CONF-950740–87: Joint ASME/JSME pressure vessels and piping conference, Honolulu, HI (United States), 23-27 Jul 1995). Order Number DE95014090. Source: OSTI; NTIS; GPO Dep.

Various measurement tools that are used in chaos theory were applied to analyze two-phase pressure signals with the objective of identifying and interpreting flow pattern transitions for two-phase flows in a small, horizontal rectangular channel. These measurement tools included power spectral density function, autocorrelation function, pseudo-phase-plane trajectory, Lyapunov exponents, and fractal dimensions. It was demonstrated that the randomlike pressure fluctuations characteristic of two-phase flow in small rectangular channels are chaotic. As such, they are governed by a high-order deterministic system. The correlation dimension is potentially a new approach for identifying certain two-phase flow patterns and transitions.

30333 (DOE/ER/14171–3) **Radiative transfer through an array of discrete surfaces. Final report.** Welty, J.R. Oregon State Univ., Corvallis, OR (United States). Dept. of Mechanical Engineering. 1 Aug 1995. 7p. Sponsored by USDOE, Washington, DC (United States). DOE Contract FG06-91ER14171. Order Number DE95017319. Source: OSTI; NTIS; GPO Dep.

The aim of this research has been to examine how the transfer of radiant energy through a two-dimensional array of typical packing elements is affected by geometric variables (spacing, packing arrangement, and element shapes). The information resulting from this study will be relevant to a spectrum of applications including fibrous insulation, ceramic fabrics, and air heating solar receivers. Computational and experimental results will also be useful in establishing criteria for the valid application of participating media models to systems of discrete surfaces. Additional studies, related to the principal goal, were undertaken as the research effort progressed. These side-issues resulted in three out of the total of 12 publications that resulted from this effort. Collaboration between OSU and PNL has been interactive regarding the experimental and numerical modeling phases of this effort with the results of one group offering guidance to the other. Accomplishments achieved during the course of this effort include the following: (1) a state-of-the-art bidirectional reflectometer was designed, constructed and operated, (2) measurements were made and the results characterized of the bidirectional reflectance of several materials, (3) it was demonstrated that there is a need for information on the full bidirectional reflectance distribution function (BDRF) to describe radiant interchange involving striated surfaces, and (4) validation of results using the two-dimensional Monte Carlo code, developed at PNL, was achieved and the code was used to extend the results of a classic geometric problem in the radiant heat transfer literature.

30334 (DOE/PC/90183–T16) **Dense inclined flows: Theory and experiments. Quarterly technical progress report, April 1–June 30, 1995.** Cornell Univ., Ithaca, NY (United States). [1995]. 4p. Sponsored by USDOE, Washington, DC (United States). DOE Contract AC22-91PC90183. Order Number DE96000930. Source: OSTI; NTIS; GPO Dep.

Rapid, gravity-driven flows of granular materials down inclines pose a challenge to the understanding of solids flow. Even in situations in which the flow is steady and two-dimensional, the details of how momentum and energy are balanced within the flow and at the bottom boundary are not well understood. Thus the authors have undertaken a research program integrating theory, computer simulation, and experiment that will focus on dense entry flows down inclines. The effort involves the development of theory informed by the results of simultaneous computer simulations and the construction, instrumentation, and use of an experimental facility in which the variables necessary to assess the success or failure of the theory can be measured. In the present reporting period, the authors began a series of measurements in the chute facility with a bumpy boundary constructed using random two-dimensional packings of 1 mm glass spheres. At the inclination of 19° and at several gate openings, they measured mass flow rate and mass holdup, as well as granular temperature and collision frequency at the bottom wall of the chute. By recording simultaneously the collisional normal stress at the bottom wall and the mass holdup above it, the experiments revealed that, unlike the flat boundary, only a small fraction of the weight of particles is supported by direct impact. The authors have also completed measurements of the impact properties for several binary collisions of nearly spherical particles used in this and other projects. A table summarizes the data obtained.

30335 (DOE/PC/92152–T16) **Measurement of extensional viscosity by the stretching of viscoelastic liquid columns. Quarterly report, April–June, 1995.** Calvo, D.; Chigier, N. Carnegie-Mellon Univ., Pittsburgh, PA (United States). Dept. of Mechanical Engineering. [1995]. 6p. Sponsored by USDOE, Washington, DC (United States). DOE Contract FG22-92PC92152. Order Number DE96000925. Source: OSTI; NTIS; GPO Dep.

Recent work in the field of atomization has explored the breakup of viscoelastic liquids. Studies have observed that viscoelastic liquids are much more resistant to breakup in comparison with Newtonian liquids. This high resistance to breakup has been attributed to the high extensional viscosities that viscoelastic liquids possess. Although extensional viscosity has been identified as having a major influence on the mode of breakup, no studies have yet been successful in correlating spray quality with a parameter that is truly description of the extensional viscosity of viscoelastic liquids. In this study, a new method is used to determine the extensional viscosities of viscoelastic liquids by the stretching of liquid columns. This method is used to show quantitative variations in extensional viscosity as a function of polymer concentration in aqueous solutions of polyacrylamide e10. Results suggest that as polymer concentration is increased, the liquids exhibit extension thickening behavior.

30336 (INIS-mf–14583) **Theoretical study to determine the heat transfer by forced convection coefficient in an empirical correlation in single phase, for annular channels.** Herrera A, E.

Instituto Politecnico Nacional, Mexico City (Mexico). Escuela Superior de Ingenieria Mecanica y Electrica. 1994. 72p. (In Spanish). Order Number DE96602711. Source: OSTI; NTIS (US Sales Only); INIS.

In the heat transfer studies by forced convection, we have few data about behavior of the fluids in an annular channel heated by a concentric pipe, such date is necessary to know the heat transfer coefficient that establish the interchange of energy and the thermic properties of the fluid with the geometry of the flow. In this work the objective, was to compare some empirical correlations that we needed for determinate the heat transfer coefficient for annular channels, where we obtained similar at the theoretical results of an experiment made by Miller and Benforado. It is important to know such coefficients because we can determinate the heat quantity transmitted to a probe zone, in which we simulate a nuclear fuel element that developed huge heat quantity that must be dispersed in short time. We give theoretical data of the heat forced transfer convection and we analyzed the phenomena in annular channels given some empirical correlations employed by some investigators and we analyzed each one. (Author).

30337 (INIS-mf–14587) **Experimental analysis of natural convection in a cavity with relation 2:1.** Reyes S, M. Instituto Politecnico Nacional, Mexico City (Mexico). Escuela Superior de Ingenieria Mecanica y Electrica. 1994. 107p. (In Spanish). Order Number DE96602713. Source: OSTI; NTIS (US Sales Only); INIS.

This work develop an experimental study of the natural convection in Transient State in a cavity of the relation 2:1 (long-height), heated by a heat flux on a side wall with the opposite wall at constant temperature and equal at the temperature of the fluid. The experimental work was made for a Rayleigh number of approximately 10^9, and the Prandtl number of 7.69. The work objective is to describe the velocity fields by mean of optic methods at different times, wide of limit layers, and searching the best visual conditions for know widely the phenomena in study. We carry out a comparison of the experimental results with the analysis of scales of Patterson and Imberger (9), with the adaptations of Poujol (19), for the condition of a constant heat flux, given this theories good results. The experimental work it have the formation of a vortex near of the hot wall, this vortex, decrease only in size during the heat transfer. In the top of the cavity in the right corner we found a divergence zone such as a "hydraulic jump" mentioned by Ivey (13), and we found too a second vortex in the bottom of the wall with constant temperature, that decrease and finally disappear when the fluid reach a permanent state. This work contribute to the mechanical design of the cavity, and at the description of the best photographic conditions for the study of the natural convection, giving good results for the study of the limit layers, thermic, hydrodynamic and the intrusion. (Author).

30338 (KRC–91G-T06) **Erosion and Heat Transfer Characteristics of a Finned Horizontal Tube in a FBC.** Ji, P.S. (Korea Electric Power Corp. (KEPCO), Taejon (Korea, Republic of). Research Center); Kim, J.J.; Ahn, D.H.; Chung, J.D.; Kim, N.H.; Chung, T.Y.; Chae, J.W.; Kang, H.S.; Eum, T.I.; Mang, M.J.; Chung, Y.C.; Back, J.H. Korea Electric Power Corp. (KEPCO), Taejon (Korea, Republic of). Research Center. 1993. 257p. (In Korean). Order Number DE96703589. Source: OSTI; NTIS (US Sales Only).

The objective of present work is to experimentally investigate the characteristics of heat transfer and erosion of horizontal tubes, equipped with radial fins of triangular profile, immersed in a high-temperature fluidized bed. Operating variables to be considered are bed temperature, superficial velocity, mean size of bed material, and the rake angle of fin. The heat transfer variations and erosion rate of the finned tube are experimentally compared with those of a smooth tube. Judging from the heat transfer and erosion test for the fluidized bed, the finned tube is considered better for the fluidized bed with horizontally equipped heat exchange tube. The reason is that, since erosion occurs at the tip region if the rake angle is appropriate for the particle size, the heat transfer rate increases for the finned tube and therefore the life cycle of the tube becomes longer. The final data may be able to be applicated for the design of the fluidized bed combustor using low grade domestic as a fuel if the operating conditions the FBC are equal to the experimental conditions of this study. (author). 71 refs., fig.

30339 (LA–10228-Del.) **Hydrodynamically driven two-phase flow, a theory of hydrodynamically driven dynamic mix.** Binstock, J. Los Alamos National Lab., NM (United States). Oct 1995. 16p. Sponsored by USDOE, Washington, DC (United States). DOE Contract W-7405-ENG-36. Order Number DE96001359. Source: OSTI; NTIS; GPO Dep.

The author writes the dynamic equations describing the intermixing of two materials starting from the conservation laws. The result is a set of equations for mixing driven by the Rayleigh-Taylor buoyancy force, and amplified by terms which incorporate the Richtmyer-Meshkov and Kelvin-Helmholtz instabilities. Making the assumption of pressure equilibration, the author arrives at equations which predict that mixing will begin, even in the limit of small initial perturbations, and even in a 1-d calculation, when an interface goes Rayleigh-Taylor unstable, unless the drag or material strength forces are sufficiently large to prevent this. The equations given here may be incorporated into 1-d, 2-d, or 3-d codes, for either Lagrangian or Eulerian formulation. They have the nice feature for Lagrangian codes of keeping the zone mass fixed, thus eliminating the need for rezoning.

30340 (LA-UR–95-2927) **Spectral analysis of the turbulent mixing of two fluids.** Steinkamp, M.J. Los Alamos National Lab., NM (United States). [1995]. 245p. Sponsored by USDOE, Washington, DC (United States). DOE Contract W-7405-ENG-36. Order Number DE95017559. Source: OSTI; NTIS; GPO Dep.

Thesis submitted to University of Illinois, Urbana-Champaign, 1995.

We describe a spectral approach to the investigation of fluid instability, generalized turbulence, and the interpenetration of fluids across an interface. The Technique also applies to a single fluid with large variations in density. Departures of fluctuating velocity components from the local mean are far subsonic, but the mean Mach number can be large. Validity of the description is demonstrated by comparisons with experiments on turbulent mixing due to the late stages of Rayleigh-Taylor instability, when the dynamics become approximately self-similar in response to a constant body force. Generic forms for anisotropic spectral structure are described and used as a basis for deriving spectrally integrated moment equations that can be incorporated into computer codes for scientific and engineering analyses.

30341 (NUREG/CP–0142-Vol.3, pp. 2021-2034) **Local mesh refinement for incompressible fluid flow with free surfaces.** Terasaka, H. (Tokyo Electric Power Company (Japan)); Kajiwara, H.; Ogura, K. Nuclear Regulatory Commission, Washington, DC (United States). Div. of Systems Technology; American Nuclear Society, La Grange Park, IL (United States); American Inst. of Chemical Engineers, New York, NY (United States); American Society of Mechanical Engineers, New York, NY (United States); Canadian Nuclear Society, Toronto, ON (Canada); European Nuclear Society (ENS), Bern (Switzerland); Atomic Energy Society of Japan, Tokyo (Japan); Japan Society of Multiphase Flow, Kyoto (Japan). Sep 1995. (CONF-950904–Vol.3: 7. international meeting on nuclear reactor thermal hydraulics, Saratoga, NY (United States), 10-15 Sep 1995). In *Proceedings of the 7th International Meeting on Nuclear Reactor Thermal-Hydraulics NURETH-7, Volume 3, Sessions 12-16.* 1001p. Source: OSTI; NTIS; INIS; GPO.

A new local mesh refinement (LMR) technique has been developed and applied to incompressible fluid flows with free surface boundaries. The LMR method embeds patches of fine grid in arbitrary regions of interest. Hence, more accurate solutions can be obtained with a lower number of computational cells. This method is very suitable for the simulation of free surface movements because free surface flow problems generally require a finer computational grid to obtain adequate results. By using this technique, one can place finer grids only near the surfaces, and therefore greatly reduce the total number of cells and computational costs. This paper introduces LMR3D, a three-dimensional incompressible flow analysis code. Numerical examples calculated with the code demonstrate well the advantages of the LMR method.

30342 (NUREG/CP–0142-Vol.4, pp. 3175-3196) **Bubble behaviour and mean diameter in subcooled flow boiling.** Zeitoun, O. (McMaster Univ., Hamilton, Ontario (Canada)); Shoukri, M. Nuclear Regulatory Commission, Washington, DC (United States).

Div. of Systems Technology; American Nuclear Society, La Grange Park, IL (United States); American Inst. of Chemical Engineers, New York, NY (United States); American Society of Mechanical Engineers, New York, NY (United States); Canadian Nuclear Society, Toronto, ON (Canada); European Nuclear Society (ENS), Bern (Switzerland); Atomic Energy Society of Japan, Tokyo (Japan); Japan Society of Multiphase Flow, Kyoto (Japan). Sep 1995. (CONF-950904–Vol.4: 7. international meeting on nuclear reactor thermal hydraulics, Saratoga, NY (United States), 10-15 Sep 1995). In *Proceedings of the 7th International Meeting on Nuclear Reactor Thermal-Hydraulics NURETH-7. Sessions 17-24.* 825p. Source: OSTI; NTIS; INIS; GPO.

Bubble behaviour and mean bubble diameter in subcooled upward flow boiling in a vertical annular channel were investigated under low pressure and mass flux conditions. A high speed video system was used to visualize the subcooled flow boiling phenomenon. The high speed photographic results indicated that, contrary to the common understanding, bubbles tend to detach from the heating surface upstream of the net vapour generation point. Digital image processing technique was used to measure the mean bubble diameter along the subcooled flow boiling region. Data on the axial area-averaged void fraction distributions were also obtained using a single beam gamma densitometer. Effects of the liquid subcooling, applied heat flux and mass flux on the mean bubble size were investigated. A correlation for the mean bubble diameter as a function of the local subcooling, heat flux and mass flux was obtained.

30343 (SAND–95-0009C) **Computational fluid dynamic analysis of a High-Velocity Oxygen-Fuel (HVOF) thermal spray torch.** Hassan, B. (Sandia National Labs., Albuquerque, NM (United States)); Oberkampf, W.L.; Neiser, R.A.; Roemer, T.J. Sandia National Labs., Albuquerque, NM (United States). [1995]. 10p. Sponsored by USDOE, Washington, DC (United States). DOE Contract AC04-94AL85000. (CONF-9509182–5: 1995 National thermal spray conference, Houston, TX (United States), 11-15 Sep 1995). Order Number DE95017886. Source: OSTI; NTIS; GPO Dep.

The gas dynamics of a High-Velocity Oxygen-Fuel (HVOF) torch are analyzed using computational fluid dynamics (CFD) techniques. The thermal spray device analyzed is similar to a Metco Diamond Jet torch with powder feed. The injection nozzle is assumed to be axisymmetric with premixed fuel and oxygen fed from an annulus, and air cooling injected along the interior surface of the aircap. The aircap, a cronically converging nozzle, achieves choked flow conditions at the exit and a supersonic, under-expanded jet develops externally. Finite difference equations for mass, momentum, and energy conservation are solved for the gas dynamics. The combustion process is modeled using a single-step and a 12-step quasi-global finite-rate chemistry model with dissociation of the gas and a total of nine species. Turbulent flow inside the aircap and in the free-jet decay is modeled using a two-equation k-ϵ model. An iterative, implicit, finite volume numerical method is used to solve the gas dynamic equations inside and outside the torch . The CFD results are compared with recent experimental measurements of pressure inside the HVOF aircap. Comparisons are made for two flow rates of premixed fuel and oxygen and air cooling. This paper presents the first published comparisons of CFD predictions and experimental measurements for HVOF tbermal spraying.

30344 (SAND–95-1992C) **Development of an electrical impedance tomography system for an air-water vertical bubble column.** O'Hern, T.J. (Sandia National Labs., Albuquerque, NM (United States)); Torczynski, J.R.; Ceccio, S.L.; Tassin, A.L.; Chahine, G.L.; Duraiswami, R.; Sarkar, K. Sandia National Labs., Albuquerque, NM (United States). [1995]. 8p. Sponsored by USDOE, Washington, DC (United States). DOE Contract AC04-94AL85000. (CONF-951135–17: International mechanical engineering congress and exhibition - winter annual meeting of the American Society of Mechanical Engineers, San Francisco, CA (United States), 12-17 Nov 1995). Order Number DE95017879. Source: OSTI; NTIS; GPO Dep.

Because the components of a multiphase flow often exhibit different electrical properties, a variety of probes have been developed to study such flows by measuring impedance in the region of interest. Researchers are now using electric fields to reconstruct the impedance distribution within a measurement volume via Electrical Impedance Tomography (EIT). EIT systems employ voltage and current measurements on the boundary of a domain to create a representation of the impedance distribution within the domain. The development of the Sandia EIT system (S-EIT) is reviewed The construction of the projection acquisition system is discussed and two specific EIT inversion algorithms are detailed. The first reconstruction algorithm employs boundary element methods, and the second utilizes finite elements. The benefits and limitations of EIT systems are also discussed. Preliminary results are provided.

30345 (UCRL-JC–120492) **Unsteady flow volumes.** Becker, B.G.; Lane, D.A.; Max, N.L. Lawrence Livermore National Lab., CA (United States). Mar 1995. 15p. Sponsored by USDOE, Washington, DC (United States);National Aeronautics and Space Administration, Washington, DC (United States). DOE Contract W-7405-ENG-48. (CONF-9510141–3: Institute for Electrical and Electronics Engineers visualization '95, Atlanta, GA (United States), 30 Oct - 3 nov 1995). Order Number DE96000080. Source: OSTI; NTIS; GPO Dep.

Flow volumes are extended for use in unsteady (time-dependent) flows. The resulting unsteady flow volumes are the 3 dimensional analog of streamlines. There are few examples where methods other than particle tracing have been used to visualize time varying flows. Since particle paths can become convoluted in time there are additional considerations to be made when extending any visualization technique to unsteady flows. We will present some solutions to the problems which occur in subdivision, rendering, and system design. We will apply the unsteady flow volumes to a variety of field types including moving multi-zoned curvilinear grids.

30346 (UCRL-JC–121781) **Relaxation spectra of surface waves.** Marcus, D.L.; Sussman, M.; Chambers, D. Lawrence Livermore National Lab., CA (United States). Aug 1995. 15p. Sponsored by USDOE, Washington, DC (United States):Department of Defense, Washington. DC (United States). DOE Contract W-7405-ENG-48. (CONF-9511129–1: Forum on advances in numerical modeling of free surface and interface fluid dynamics, San Francisco, CA (United States), 12 Nov 1995). Order Number DE96000346. Source: OSTI; NTIS; GPO Dep.

A new method is described for computing free surface flows. The method allows for arbitrary wind profiles to be imposed above the surface as well as arbitrary subsurface current and density profiles. The method combines recent advances in projection methods for stratified flows with level set strategies for computing the motion of a distinguished interface. High resolution discretization. schemes provide robust and accurate treatment of advection, even for singular initial data and in the limit of vanishing viscosity. The method is applied to the modulation of a nonlinear Stokes wave by wind applied at the surface. Speeds of 4,6, and 8 m/s relative to the rest frame are considered. The initial relaxation rate, β, is calculated. The phase and phase speeds of the complex Fourier coefficient of the fundamental are found to increase with wind speed.

30347 (UCRL-MA–121344) **HYDRA, A finite element computational fluid dynamics code: User manual.** Christon, M.A. Lawrence Livermore National Lab., CA (United States). Jun 1995. 98p. Sponsored by USDOE, Washington, DC (United States). DOE Contract W-7405-ENG-48. Order Number DE96000821. Source: OSTI; NTIS; GPO Dep.

HYDRA is a finite element code which has been developed specifically to attack the class of transient, incompressible, viscous, computational fluid dynamics problems which are predominant in the world which surrounds us. The goal for HYDRA has been to achieve high performance across a spectrum of supercomputer architectures without sacrificing any of the aspects of the finite element method which make it so flexible and permit application to a broad class of problems. As supercomputer algorithms evolve, the continuing development of HYDRA will strive to achieve optimal mappings of the most advanced flow solution algorithms onto supercomputer architectures. HYDRA has drawn upon the many years of finite element expertise constituted by DYNA3D and NIKE3D Certain key architectural ideas from both DYNA3D and NIKE3D have been adopted and further improved to fit the advanced dynamic memory management and data structures implemented in HYDRA. The philosophy for HYDRA is to focus on

mapping flow algorithms to computer architectures to try and achieve a high level of performance, rather than just performing a port.

30348 (WSRC-MS–95-0384) **Engineering Model of Liquid Storage Utility Tank for Heat Transfer Analysis.** Kwon, K.C. Westinghouse Savannah River Co., Aiken, SC (United States). 27 Sep 1995. 10p. Sponsored by USDOE, Washington, DC (United States). DOE Contract AC09-89SR18035. (CONF-951010–2: International joint power generation conference and exposition, Minneapolis, MN (United States), 8-12 Oct 1995). Order Number DE96060014. Source: OSTI; NTIS; GPO Dep.

The utility or chemical storage tank requires special engineering attention and heat transfer analysis because the tank content is very sensitive to temperature and surrounding environment such as atmospheric or outside air, humidity, and solar radiation heat. A simplified heat transfer model was developed to calculate the liquid content temperature of utility storage tank. The content of the utility storage tanks can be water or any other chemical liquid. An engineering model of liquid storage tank for heat transfer analysis and temperature calculations are presented and discussed in the examples of Tanks No. 1 containing oxalic acid and No. 2 containing sodium tetraphenylborate solution.

4205 Materials Testing

Refer also to citation(s) 28986, 29434, 29566, 30036, 30290, 30293, 30314, 30550, 31123

30349 (DOE/CE/23810–50) **Methods development for measuring and classifying flammability/combustibility of refrigerants. Final report.** Heinonen, E.W. (Univ. of New Mexico, Albuquerque, NM (United States)); Tapscott, R.E.; Crawford, F.R. Air-Conditioning and Refrigeration Inst., Arlington, VA (United States). Dec 1994. 83p. Sponsored by USDOE, Washington, DC (United States). DOE Contract FG02-91CE23810. Order Number DE96000962. Source: OSTI; NTIS; GPO Dep.

Because of concerns for the effect that chlorofluorocarbon (CFC) fluids currently in use as refrigerants have on the environment, the refrigeration industry is considering the use of natural refrigerants, many of which are potentially flammable. In some cases, these flammable fluids may result in the least environmental damage when considering ozone depletion, global warming, efficiency, and photochemical reactivity. Many potentially flammable fluids have been proven to be effective when used either by themselves or as a part of a binary or ternary mixture. However, despite favorable initial test results, these fluids may not be acceptable to the general public if questions of safety cannot be adequately addressed. Significant research is being conducted to investigate the flammability of these materials. The purpose of this project is to experimentally determine the impact and variability of eleven different parameters which may affect flammability and/or combustibility of refrigerants and refrigerant blends, as a function of composition and test conditions, and to develop a better understanding of methods and conditions to measure the flammability of refrigerants. The refrigerants used in this study are being considered as new refrigerants and reviewed published data on these materials is scarce. The data contained herein should not be considered complete and should be used only to make relative comparisons of the impacts of the test parameters, not to represent the flammability characteristics of the materials. This report documents Task 3 of the test program. During Task 1, technical literature was thoroughly reviewed and a database of available documents was constructed. During Task 2, the test plan for this task was written. The goals of Task 3 are to investigate the flammability characteristics of selected blends of refrigerants R32, R134a, and R125 using an existing explosion sphere and a newly-constructed ASTM E681 apparatus.

30350 (SAND–94-3230C) **Failure analysis of a fiberglass-reinforced plastic pressure vessel.** Glass, S.J.; Beauchamp, E.K.; Carr, M.; Guess, T.R.; Monroe, S.L.; Moore, R.J.; Slavin, A.; Sorenson, N.R. Sandia National Labs., Albuquerque, NM (United States). [1995]. 20p. Sponsored by USDOE, Washington, DC (United States). DOE Contract AC04-94AL85000. (CONF-950739–1: 3. Alfred conference on fractography of glasses and ceramics, Alfred, NY (United States), 9-12 Jul 1995). Order Number DE95017896. Source: OSTI; NTIS; GPO Dep.

A fiberglass-reinforced plastic (FRP) pressure vessel containing sulfuric acid failed catastrophically in service. Preliminary investigations ruled out failure due to sabotage and chemical or mechanical overpressure. Subsequent examination of the fiber fracture surfaces and measurements of mirror radii indicated that fiber failure had occurred at stresses significantly below the fibers' expected strength. Further examination by scanning electron microscopy and energy dispersive spectroscopy indicated that the glass fibers had been exposed to sulfuric acid, a reagent that corrodes this type of glass and degrades its strength. Finite element analysis indicated stresses in an exposed region of the vessel that exceeded the strengths of the FRP during normal vessel operation. Numerous cracks were detected in this region using a vicinal optical illumination technique. We concluded that vessel failure was caused by progressive degradation and rupture of fibers starting at the outer surface of the FRP and extending inwards and laterally, until a crack of critical size was produced.

30351 (SAND–95-0518C) **Hypervelocity impact phenomena.** Chhabildas, L.C. Sandia National Labs., Albuquerque, NM (United States). [1995]. 13p. Sponsored by USDOE, Washington, DC (United States). DOE Contract AC04-94AL85000. (CONF-950856–1: 4. international conference on metallurgical and materials applications of shock-wave and high-strain-rate phenomena, El Paso, TX (United States), 6-10 Aug 1995). Order Number DE95015433. Source: OSTI; NTIS; GPO Dep.

There is a need to determine the equations of state of materials in regimes of extreme high pressures, temperatures and strain rates that are not attainable on current two-stage light-gas guns. Understanding high-pressure material behavior is crucial to address the physical processes associated with a variety of hypervelocity impact events related to space sciences-orbital-debris impact, debris-shield designs, high-speed plasma propagation, and impact lethality applications. At very high impact velocities material properties will be dominated by phase-changes, such as melting or vaporization, which cannot be achieved at lower impact velocities. Development of well-controlled and repeatable hypervelocity launch capabilities is the first step necessary to improve our understanding of material behavior at extreme pressures and temperatures not currently available using conventional two-stage light-gas gun techniques. In this paper, techniques that have been used to extend both the launch capabilities of a two-stage light gas gun to 16 km/s, and their use to determine the material properties at pressures and temperature states higher than those ever obtained in the laboratory are summarized. The newly developed hypervelocity launcher (HVL) can launch intact (macroscopic dimensions) plates to 16 km/s. Time-resolved interferometric techniques have been used to determine shock-loading/release characteristics of materials impacted by such fliers as well as shock-induced vaporization phenomena in fully vaporized states. High-speed photography or radiography has been used to evaluate the debris propagation characteristics resulting from disc impact of thin bumper sheets at hypervelocities in excess of 10 km/s using the HVL. Examples of these experiments are provided in this paper.

30352 (SAND–95-2271C) **Characterization of a resonant plate shock system using finite element analysis.** Gute, G.D. (Missouri Univ., Kansas City, MO (United States)); Moore, D.G. Sandia National Labs., Albuquerque, NM (United States). [1995]. 12p. Sponsored by USDOE, Washington, DC (United States). DOE Contract AC04-94AL85000. (CONF-9510195–4: 66. shock and vibration symposium, Biloxi, MS (United States), 31 Oct - 3 nov 1995). Order Number DE96000779. Source: OSTI; NTIS; GPO Dep.

The dynamic performance of a 250 Hz resonant plate shock system which simulates pyrotechnic shock environments on microelectrical components is evaluated. A series of experiments recording strain rate histories and acceleration time histories at several plate locations were conducted. This empirical data is used to compare the analytical results obtained from a finite element based numerical simulation. The comparison revealed a good correlation between experimental and analytical results.

30353 (UCRL-JC–120330) **Stimulated dual-band infrared computed tomography: A tool to inspect the aging infrastructure.** Del Grande, N.K.; Durbin, P.F. Lawrence Livermore National Lab., CA (United States). 27 Jun 1995. 8p. Sponsored by USDOE, Washington, DC (United States);Federal Aviation Administration, Washington, DC (United States);Federal Highway Administration, Washington, DC (United States). DOE Contract W-7405-ENG-48. (CONF-950793–46: 40. annual meeting of the Society of Photo-Optical Instrumentation Engineers, San Diego, CA (United States), 9-14 Jul 1995). Order Number DE96000079. Source: OSTI; NTIS; GPO Dep.

The authors have developed stimulated dual-band infrared (IR) computed tomography as a tool to inspect the aging infrastructure. The system has the potential to locate and quantify structural damage within airframes and bridge decks. Typically, dual-band IR detection methods improve the signal-to-noise ratio by a factor of ten, compared to single-band IR detection methods. They conducted a demonstration at Boeing using a uniform pulsed-heat source to stimulate IR images of hidden defects in the 727 fuselage. The dual-band IR camera and image processing system produced temperature, thermal inertia, and cooling-rate maps. In combination, these maps characterized the defect site, size, depth, thickness and type. The authors quantified the percent metal loss from corrosion above a threshold of 5%, with overall uncertainties of 3%. Also, they conducted a feasibility study of dual-band IR thermal imaging for bridge deck inspections. They determined the sites and relative concrete displacement of 2-in. and 4-in. deep delaminations from thin styrofoam implants in asphalt-covered concrete slabs. They demonstrated the value of dual-band IR computed tomography to quantify structural damage within flash-heated airframes and naturally-heated bridge decks.

30354 (UCRL-JC–121878) **Generation of pseudotachylites in shock experiments: Implications for impact cratering products and processes.** Fiske, P.S. (Lawrence Livermore National Lab., CA (United States)); Nellis, W.J.; Lorenzana, H.; Lipp, M.; Kikuchi, M.; Syono, Y. Lawrence Livermore National Lab., CA (United States). 9 Aug 1995. 5p. Sponsored by USDOE, Washington, DC (United States). DOE Contract W-7405-ENG-48. (CONF-950846–45: American Physical Society biennial conference on shock compression of condensed matter, Seattle, WA (United States), 13-18 Aug 1995). Order Number DE96000361. Source: OSTI; NTIS; GPO Dep.

Meteorite impacts produce enormous pressure and strain in rocks. While the role of pressure on the formation of shock metamorphic features has been well studied, the role of strain and strain rate has not been fully appreciated. We shock loaded single-crystal quartz in Al capsules up to 56 GPa using a novel capsule design that allows for significant strain of the sample but 100% recovery of material. We have made features analogous to type A pseudotachylites at pressures of 42–56 GPa. These pseudotachylites contain Al, Si and minor Al_2O_3 in a matrix of SiO_2 class and cut the sample along radial and concentric fractures. Our results suggest that strain heating is an important energy sink in the formation of large impact craters.

4210 Combustion Systems

Refer also to citation(s) 28668, 28669, 28670, 29974, 30338, 31379

30355 (KRC–90I-J02) **The Development and Application of Digital Distributed Control System for Boiler in the Power Plant.** Her, S.K. (Korea Electric Power Corp. (KEPCO), Taejon (Korea, Republic of). Research Center); Park, I.S.; Rtu, H.W.; Kim, E.K.; Kim, C.S.; Chung, H.Y.; Im, I.H.; Han, K.H.; Bae, B.H.; Ser, I.Y.; Oh, K.T.; Park, D.Y.; Oh, E.S.; Park, I.S.; Park, C.O.; Lee,.Korea Electric Power Corp. (KEPCO), Taejon (Korea, Republic of). Research Center. 1993. 673p. (In Korean). Order Number DE96703598. Source: OSTI; NTIS (US Sales Only).

The need to replace pneumatic control system or analog control is increasing in domestic power plants. Control systems for thermal power plants were originally designed for base load operations. But the system are operating for base DSS(Daily Start and Stop) or WSS(Weekly Start and Stop) as nuclear power plants have operated for base load operations. Thus the need is being increased more and more. Digital distributed control systems have applied for modern control systems since 1980. A few vendors of advanced countries have supplied distributed control systems for control systems of domestic power plants with high costs in both installation and maintenance. Also the difficulty in the supply of components is estimated because of rapid changes in technical advancement. Therefore, development of the digital distributed control system is highly desirable to solve these problems.

30356 (WSRC-TR–95-0016) **Consolidated Incineration Facility waste burn test. Final report.** Burns, D.B. Westinghouse Savannah River Co., Aiken, SC (United States). 11 Jan 1995. 75p. Sponsored by USDOE, Washington, DC (United States). DOE Contract AC09-89SR18035. Order Number DE95017492. Source: OSTI; NTIS; INIS; GPO Dep.

The Savannah River Technology Center (SRTC) is Providing technical support for start-up and operation of the Consolidated Incineration Facility. This support program includes a series of pilot incineration tests performed at the Environmental Protection Agency's (EPA's) Incineration Research Facility (MF) using surrogate CIF mixed wastes. The objectives for this test program included measuring incinerator offgas particulate loading and size distributions as a function of several operating variables, characterizing kiln bottom ash and offgas particulates, determining heavy metal partition between the kiln bottom ash and incinerator stack gas, and measuring kiln organics emissions (particularly polychlorinated dioxins and furans). These tests were designed to investigate the effect of the following operating parameters: Incineration Temperature: Waste Feed Rate; Waste Density; Kiln Solids Residence Time; and Waste Composition. Tests were conducted at three kiln operating temperatures. Three solid waste simulants were burned, two waste mixtures (paper, plastic, latex, and PVC) with one containing spiked toxic organic and metal compounds, and one waste type containing only paper. Secondary Combustion Chamber (SCC) offgases were sampled for particulate loading and size distribution, organic compounds, polychlorinated dibenzo[p]dioxins and polychlorinated dibenzofurans (PCDD/PCDF), metals, and combustion products. Kiln bottom ash and offgas particulates were characterized to determine the principal elements and compounds comprising these secondary wastes.

4220 Mining and Underground Engineering

Refer also to citation(s) 29089, 29411

30357 (LA-SUB–95-101) **The effects of structural setting on the azimuthal velocities of blast induced ground motion in perlite.** Beattie, S.G. (New Mexico Inst. of Mining and Technology, Socorro, NM (United States)). Los Alamos National Lab., NM (United States); New Mexico Inst. of Mining and Technology, Socorro, NM (United States). Feb 1995. 222p. Sponsored by USDOE, Washington, DC (United States). DOE Contract W-7405-ENG-36. Order Number DE95017361. Source: OSTI; NTIS; GPO Dep.

Thesis submitted to New Mexico Institute of Mining and Technology, Socorro, New Mexico.

A series of small scale explosive tests were performed during the spring of 1994 at a perlite mine located near Socorro, NM. The tests were designed to investigate the azimuthal or directional relationship between small scale geologic structures such as joints and the propagation of explosively induced ground motion. Three shots were initiated within a single borehole located at ground zero (gz) at depths varying from the deepest at 83 m (272 ft) to the shallowest at 10 m (32 ft). The intermediate shot was initiated at a depth of 63 m (208 ft). An array of three component velocity and acceleration transducers were placed in two concentric rings entirely surrounding the single shot hole at 150 and 300 azimuths as measured from ground zero. Data from the transducers was then used to determine the average propagation velocity of the blast vibration through the rock mass at the various azimuths. The rock mass was mapped to determine the prominent joint orientations (strike and dip) and the average propagation velocities were correlated with this geologic information. The data from these experiments shows that there is a correlation between the orientation of prominent joints and the average velocity of ground motion. It is theorized that this relationship is due to the relative path the ground wave

follows when encountering a joint or structure within the rock mass. The more prominent structures allow the wave to follow along their strike thereby forming a sort of channel or path of least resistance and in turn increasing the propagation velocity. Secondary joints or structures may act in concert with more prominent features to form a network of channels along which the wave moves more freely than it may travel against the structure. The amplitudes of the ground motion was also shown to vary azimuthally with the direction of the most prominent structures.

4230 Marine Engineering

30358 (ETDE-DE–203) **Earthquake loading on offshore structures. Final report.** Klingmueller, O.; Hedeler, D.; Mehlhorn, W.; Wittemann, G.; Wagner, P. Bilfinger und Berger Bauaktiengesellschaft, Mannheim (Germany). 1994. 185p. (In German, English). Sponsored by Bundesministerium fuer Forschung und Technologie, Bonn (Germany). Foerderkennzeichen BMFT MTK0495. Order Number DE96706596. Source: OSTI; NTIS (US Sales Only).

The objective of the R and D-project 'Earthquake Loading on Offshore Structures' is the development of a practically applicable and code conforming design concept for Concrete Offshore Monotowers. The hydrodynamic analysis has been carried out by the Technical University of Hamburg Harburg, Department of Offshore Technology II (TUHH, Arbeitsgebiet Meerestechnik II). The structural design concept has been developed by the Technical Staff of Bilfinger and Berger Bauaktiengesellschaft in Cooperation with the Gesellschaft fuer Schwingungsuntersuchungen und dynamische Pruefmethoden mbH in Mannheim. As the main results of the research project the following is available: 1. Easy to use graphic solutions for the hydrodynamic actions and fluid-structure-interaction of monotowers of arbitrary geometrical shape, 2. A consistent design concept, where fluid-structure-interaction is implemented in a determination of earthquake effects by the widely used method of design response spectra. Besides some basic investigations into the mechanics of fluid actions on earthquake excited bodies especailly the importane of the earthquake for the design of the structure has been analysed by so called earthquake factors. In addition neighbouring problems of fluid structure interaction of liquid storage tanks and arch dams has been discussed. This final report contains a comprehensive description of the results of the work. Previously released intermediate reports as well as publications and presentations from the project are included in the appendix. (orig.)

4260 Components, Electron Devices and Circuits

Refer also to citation(s) 29165, 29166, 29784, 29947, 30147, 30168, 30172, 30189, 30403, 30467, 30490, 30495, 30537, 30547, 30549, 30615, 31198, 31199, 31211, 31223, 31224, 31238, 31239, 31243, 31245, 31255, 31257, 31258, 31259, 31261, 31263, 31265, 31267, 31270, 31271, 31283, 31331

30359 (BNL–52292-Vol.3) **Selected topics in particle accelerators: Proceedings of the CAP meetings. Volume 3.** Parsa, Z. (ed.) (comp.). Brookhaven National Lab., Upton, NY (United States). [1995]. 293p. Sponsored by USDOE, Washington, DC (United States). DOE Contract AC02-76CH00016. (CAP–123-95P). Order Number DE96000436. Source: OSTI; NTIS; INIS; GPO Dep.

Viewgraphs.

This Report includes copies of transparencies and notes from the presentations made at the Center for Accelerator Physics at Brookhaven National Laboratory. Editing and changes to authors' contributions in this Report were made only to fulfill the publication requirements. This volume includes notes and transparencies on eight presentations: "Inverse Cherenkov Laser Acceleration of Electron Beams", "High Brightness Field Emission Cathodes", "QCD/Teraflop Collaboration: The Future of Supercomputing", "Report on Dipole R&D", "Reaching Maximum Luminosity in Hadron Colliders at 10-100 TeV", "STAR Collaboration Project Status Report: Quarks and Gluons", "PHENIX Collaboration Project Status Report", and "Update on Status of BNL Relativistic Heavy Ion Collider (RHIC) Project: RHIC Design Issues."

30360 (BNL–52292-Vol.5) **Selected topics in particle accelerators: Proceedings of the CAP meetings. Volume 5.** Parsa, Z. (ed.) (comp.). Brookhaven National Lab., Upton, NY (United States). [1995]. 388p. Sponsored by USDOE, Washington, DC (United States). DOE Contract AC02-76CH00016. (CAP–125-95P-Vol.5). Order Number DE96000438. Source: OSTI; NTIS; INIS; GPO Dep.

Viewgraphs.

This Report includes copies of transparencies and notes from the presentations made at the Center for Accelerator Physics at Brookhaven National Laboratory Editing and changes to the authors' contributions in this Report were made only to fulfill the publication requirements. This volume includes notes and transparencies on nine presentations: "The Energy Exchange and Efficiency Consideration in Klystrons", "Some Properties of Microwave RF Sources for Future Colliders + Overview of Microwave Generation Activity at the University of Maryland", "Field Quality Improvements in Superconducting Magnets for RHIC", "Hadronic B-Physics", "Spiking Pulses from Free Electron Lasers: Observations and Computational Models", "Crystalline Beams in Circular Accelerators", "Accumulator Ring for AGS & Recent AGS Performance", "RHIC Project Machine Status", and "Gamma-Gamma Colliders."

30361 (CONF-941115–2) **Improved near surface heavy impurity detection by a novel charged particle energy filter technique.** Ishibashi, K. (North Carolina Univ., Chapel Hill, NC (United States). Dept. of Physics and Astronomy); Patnaik, B.K.; Parikh, N.R.; Tateno, H.; Hunn, J.D. Oak Ridge National Lab., TN (United States). [1994]. 6p. Sponsored by USDOE, Washington, DC (United States). DOE Contract AC05-84OR21400. From Fall meeting of the Materials Research Society; Boston, MA (United States); 28 Nov - 2 dec 1994. Order Number DE95014258. Source: OSTI; NTIS; INIS; GPO Dep.

As the typical feature size of silicon integrated circuits, such as in VLSI technology, has become smaller, the surface cleanliness of silicon wafers has become more important. Hence, detection of trace impurities introduced during the processing steps is essential. A novel technique, consisting of a "Charged Particle Energy Filter (CPEF)" used in the path of the scattered helium ions in the conventional Rutherford Backscattering geometry, is proposed and its merits and limitations are discussed. In this technique, an electric field is applied across a pair of plates placed before the detector so that backscattered particles of only a selected energy range go through slits to strike the detector. This can be used to filter out particles from the lighter substrate atoms and thus reduce pulse pileup in the region of the impurity signal. The feasibility of this scheme was studied with silicon wafers implanted with 1×10^{14} and 1×10^{13} $^{54}Fe/cm^2$ at an energy of 35 keV, and a 0.5 MeV He^+ analysis beam. It was found that the backscattered ion signals from the Si atoms can be reduced by more than three orders of magnitude. This suggests the detection limit for contaminants can be improved by at least two orders of magnitude compared to the conventional Rutherford Backscattering technique. This technique can be incorporated in 200–300 kV ion implanters for monitoring of surface contaminants in samples prior to implantation.

30362 (KCP–613-5564) **MAST 1 purchased products–components. Final report.** Brown, R.J. Allied-Signal Aerospace Co., Kansas City, MO (United States). Kansas City Div. Oct 1995. 15p. Sponsored by USDOE, Washington, DC (United States). DOE Contract AC04-76DP00613. Order Number DE96001629. Source: OSTI; NTIS; GPO Dep.

AlliedSignal Inc., Kansas City Division, the production agency, was provided with funding to acquire purchased product components in support of the MAST (Multi-Application Surety Technology) Program. Implementation efforts, closing procurement status, and proposals for improvements in the procurement process are presented. The intent of this project was to fund the Purchased Product Team's traditional procurement of components, with significantly reduced flowtime, in accordance with the Qualification Evaluation System, and to exercise the system to the extent possible. When funding was reduced, it became obvious that full implementation of the Qualification Evaluation System could not be achieved due to limited resources.

30363 (LA-UR–95-2408) **Charge Transfer Efficiency modeling/measurements as function of CCD pixel rate.** Yates, G.J. (Los Alamos National Lab., NM (United States)); Gallegos, R.; Pena, C.; Zagarino, P. Los Alamos National Lab., NM (United States). [1995]. 16p. Sponsored by USDOE, Washington, DC (United States). DOE Contract W-7405-ENG-36. (CONF-950793–18: 40. annual meeting of the Society of Photo-Optical Instrumentation Engineers, San Diego, CA (United States), 9-14 Jul 1995). Order Number DE95016890. Source: OSTI; NTIS; GPO Dep.

We have developed a charge transport model for predicting the effects on Charge Transfer Efficiency (CTE) of Charge Coupled Devices (CCDs) as functions of number of transfers, pixel charge flow rate, and magnitude in the CCD's vertical and horizontal charge transport mediums. The model uses carrier lifetime an mobility criteria to establish pixel speed arguments and limitations for various CCD architectures. The model is compared with experimental measurements obtained using strobed single pixel illumination and a variant of the deferred charge tail technique while independently varying the CCD pixel rates for both the vertical and horizontal readout phases. The generic model is discussed and applied to specific real CCDs. Agreement between predicted performance and actual measured performance is presented.

30364 (LA-UR–95-2552) **Plasma flow switch experiment on Procyon.** Benage, J.F. Jr. (and others); Bowers, R.; Peterson, D. Los Alamos National Lab., NM (United States). [1995]. 7p. Sponsored by USDOE, Washington, DC (United States). DOE Contract W-7405-ENG-36. (CONF-950750–21: 10. Institute of Electrical and Electronics Engineers (IEEE) pulsed power conference, Albuquerque, NM (United States), 10-13 Jul 1995). Order Number DE95017002. Source: OSTI; NTIS; GPO Dep.

This report presents the results obtained from a series of plasma flow switch experiments done on the Procyon explosive pulse power generator. These experiments involved switching into a fixed inductance dummy load and also into a dynamic implosion load. The results indicated that the switch did fairly well at switching current into the load, but the results for the implosion are more ambiguous. The results are compared to calculations and the implications for future plasma flow switch work are discussed.

30365 (LBL–37147) **Energy spread of ion beams generated in multicusp ion sources.** Sarstedt, M. (and others); Herz, P.; Kunkel, W.B. Lawrence Berkeley Lab., CA (United States). Apr 1995. 3p. Sponsored by USDOE, Washington, DC (United States). DOE Contract AC03-76SF00098. (CONF-950512–334: Particle accelerator conference, Dallas, TX (United States), 1-5 May 1995). Order Number DE96000189. Source: OSTI; NTIS; INIS; GPO Dep.

For the production of future microelectronics devices, various alternate methods are currently being considered to replace the presently used method of lithography with ion beam lithography. One of these methods is the Ion Projection Lithography (IPL), which aims at the possibility of projecting sub-0.25 μm patterns of a stencil mask onto a wafer substrate. In order to keep the chromatic aberrations below 25 nm, an ion source which delivers a beam with energy spread of less than 3 eV is desired. For this application, multicusp ion sources are being considered. We measure the longitudinal energy spread of the plasma ions by using a two-grid electrostatic energy analyzer. The energy spread of the extracted beam is measured by a high-voltage retarding-field energy analyzer. In order to obtain the transverse ion temperature, a parallel-plate scanner is being set up to study the beam emittance. In this paper, comparisons are made for different ion source configurations.

30366 (LBL–37151) **Compton scattering in the ALS booster.** Robin, D.; Kim, C.; Sessler, A. Lawrence Berkeley Lab., CA (United States). Apr 1995. 3p. Sponsored by USDOE, Washington, DC (United States). DOE Contract AC03-76SF00098. (LSGN–206; CONF-950512–322: Particle accelerator conference, Dallas, TX (United States), 1-5 May 1995). Order Number DE96000145. Source: OSTI; NTIS; GPO Dep.

Femtosecond x-ray pulses may be generated by 90° Compton side scattering of a short visible laser beam by a well-focused relativistic electron beam. A proof-of-principle experiment is underway using the ALS linac. From this experiment an x-ray pulse of 10^5 photons with a duration of 230 fs in a bandwidth of 10% at 10 Hz is expected. In this paper we explore using the ALS booster instead to increase the average x-ray flux. To generate the small beam size we plan to radiation damp electrons by accelerating them to 600 MeV and decelerate quickly to 50 MeV before intra-beam scattering can increase the beam size. We can achieve a vertical emittance of $<5 \times 10^{-9}$ m-rad. With a small modification of the booster lattice it is possible to focus the beam to a vertical beta function of $B_y^* = 10$ cm. By reflecting the incident laser pulse many times we expect to be able to obtain an increase of the average x-ray flux.

30367 (LBL–37249) **Nonlinear dynamics of additive pulse modelocked lasers.** Sucha, G. (Lawrence Berkeley Lab., CA (United States). Materials Sciences Div.); Bolton, S.R.; Chemla, D.S. Lawrence Berkeley Lab., CA (United States). Apr 1995. 2p. Sponsored by USDOE, Washington, DC (United States). DOE Contract AC03-76SF00098. (CONF-9506263–1: Nonlinear dynamics in optical systems, Rochester, NY (United States), 7-10 Jun 1995). Order Number DE96000135. Source: OSTI; NTIS; GPO Dep.

Nonlinear dynamics have been studied in a number of modelocked laser systems, primarily in actively modelocked systems. However, less attention has been paid to the dynamics of passively modelocked laser systems. With the recent revolutionary advances in femtosecond modelocked laser technology, the understanding of instabilities and dynamics in passively modelocked lasers is an important issue. Here, the authors present experimental and numerical studies of the dynamics of an additive-pulse modelocked (APM) color-center laser.

30368 (LBL–37267) **Plasma synthesis of rare earth doped integrated optical waveguides.** Raoux, S. (Lawrence Berkeley Lab., CA (United States)); Anders, S.; Yu, K.M.; Brown, I.G.; Ivanov, I.C. Lawrence Berkeley Lab., CA (United States). Mar 1995. 6p. Sponsored by USDOE, Washington, DC (United States). DOE Contract AC03-76SF00098. (CONF-950412–43: Spring meeting of the Materials Research Society (MRS), San Francisco, CA (United States), 17-21 Apr 1995). Order Number DE95016465. Source: OSTI; NTIS; GPO Dep.

We describe a novel means for the production of optically active planar waveguides. The makes use of a low energy plasma deposition. Cathodic-arc-produced metal plasmas the metallic components of the films and gases are added to form compound films. Here we discuss the synthesis of $Al_{2-x}ER_xO_3$ thin films. The erbium concentration (x) can vary from 0 to 100% and the thickness of the film can be from Angstroms to microns. In such material, at high active center concentration (x=l% to 20%), erbium ions give rise to room temperature 1.53μm emission which has minimum loss in silica-based optical fibers. With this technique, multilayer integrated planar waveguide structures can be grown, such as $Al_2O_3/Al_{2-x}Er_xO_3/Al_2O_3/Si$, for example.

30369 (NEDO-IT–9304) **Phase control technology for high-quality laser beam generation and the survey for its application.** New Energy and Industrial Technology Development Organization, Tokyo (Japan). Mar 1994. 246p. (In Japanese). Order Number DE96704378. Source: OSTI; NTIS; Available from New Energy and Industrial Technology Development Organization, Sunshine 60, 30F 1-1, 3-chome, Higashi-Ikebukuro, Toshima-ku, Tokyo, Japan.

A survey was made in detail on phase conjugation technology, optical compensation technology and phase measurement technology which are particularly important out of optical phase control technologies, and on applications of these technologies. As for mediums used for creation of phase conjugation, photo refractive optical crystals, organic materials, etc. are developed in the shape of thin films and optical fiber for continuous oscillation laser beams use. For pulse oscillation laser beams use, new mediums such as frolinate were found out and they obtained favorable effects. As a method to control and compensate optical phase, variable shape mirror was developed. In a trial manufacture of the mirror, obtained were surface precision of $\lambda/8$ of the wavelength and response speed of 1 kHz or higher. Applications of phase control technology are to a wide range of fields such as improvement of laser processing precision by heightening of quality, detection of defeats of LSI, measurement of micro-vibration, reduced deterioration of laser

radar resolution, R and D of novelty filters, optical arithmetic, and associate memory. 317 refs., 136 figs., 30 tabs.

30370 (PNL-SA-24317) **An accurate, efficient algorithm for calculation of quantum transport in extended structures.** Godin, T.J. (Pacific Northwest Lab., Richland, WA (United States). Molecular Science Research Center); Haydock, R. Pacific Northwest Lab., Richland, WA (United States). May 1994. 7p. Sponsored by USDOE, Washington, DC (United States). DOE Contract AC06-76RL01830. (CONF-9505257--1: International workshop on computational electronics, Portland, OR (United States), 18-20 May 1995). Order Number DE95014177. Source: OSTI; NTIS; GPO Dep.

In device structures with dimensions comparable to carrier inelastic scattering lengths, the quantum nature of carriers will cause interference effects that cannot be modeled by conventional techniques. The basic equations that govern these "quantum" circuit elements present significant numerical challenges. The authors describe the block recursion method, an accurate, efficient method for solving the quantum circuit problem. They demonstrate this method by modeling dirty inversion layers.

30371 (SAND-94-1451) **Aging, stressing and solderability of electroplated and electroless copper.** Sorensen, N.R.; Hosking, F.M. Sandia National Labs., Albuquerque, NM (United States). Aug 1995. 15p. Sponsored by USDOE, Washington, DC (United States). DOE Contract AC04-94AL85000. Order Number DE95017638. Source: OSTI; NTIS; GPO Dep.

Organic inhibitors can be used to prevent corrosion of metals have application in the electronics industry as solderability preservatives. We have developed a model to describe the action of two inhibitors (benzotriazole and imidazole) during the environmental aging and soldering process. The inhibitors bond with the metal surface and form a barrier that prevents or retards oxidation. At soldering temperatures, the metal-organic complex breaks down leaving an oxide-free metal surface that allows excellent wetting by the molten solder. The presence of the inhibitor retards the wetting rate relative to clean copper but provides a vast improvement relative to oxidized copper.

30372 (SAND-95-0514C) **Effects of reliability screens of MOS charge trapping.** Shanneyfelt, M.R.; Winokur, P.S.; Fleetwood, D.M.; Schwank, J.R.; Reber, R.A. Jr. Sandia National Labs., Albuquerque, NM (United States). [1995]. 10p. Sponsored by USDOE, Washington, DC (United States). DOE Contract AC04-94AL85000. (CONF-9509107--1: 3. European symposium on radiations and their effects on components and systems, Arcachon (France), 18-22 Sep 1995). Order Number DE95017838. Source: OSTI; NTIS; GPO Dep.

The effects of pre-irradiation elevated-temperature bias stresses on the radiation hardness of field-oxide transistors have been investigated as a function of stress temperature, time, and bias. Both the stress temperature and time are found to have a significant impact on radiation-induced charge buildup in these transistors. Specifically, an increase in either the stress temperature or time causes a much larger negative shift (towards depletion) in the I-V characteristics of the n-channel field-oxide transistors. This increased shift in the transistor I-V characteristics with stress temperature and time suggests that the mechanisms responsible for the stress effects are thermally activated. An activation energy of ~0.38 eV was measured. The stress bias was found to have no impact on radiation-induced charge buildup in these transistors. The observed stress temperature, time, and bias dependencies appears to be consistent with the diffusion of molecular hydrogen during a given stress period. These results have important implications for the development of hardness assurance test methods.

30373 (SAND-95-1059C) **Frequency doubling in poled polymers using anomalous dispersion phase-matching.** Kowalczyk, T.C. (Case Western Reserve Univ., Cleveland, OH (United States). Dept. of Physics); Singer, K.D.; Cahill, P.A. Sandia National Labs., Albuquerque, NM (United States). [1995]. 15p. Sponsored by USDOE, Washington, DC (United States). DOE Contract AC04-94AL85000. (CONF-9509141--1: 11. interdisciplinary laser science conference: annual meeting of the American Physical Society's Laser Science Topical Group; OSA fall conference, Portland, OR (United States), 10-15 Sep 1995). Order Number DE96000756. Source: OSTI; NTIS; GPO Dep.

The authors report on a second harmonic generation in a poled polymer waveguide using anomalous dispersion phase-matching. Blue light (λ = 407 nm) was produced by phase-matching the lowest order fundamental and harmonic modes over a distance of 32 μm. The experimental conversion efficiency was $\eta = 1.2 \times 10^{-4}$, in agreement with theory. Additionally, they discuss a method of enhancing the conversion efficiency for second harmonic generation using anomalous dispersion phase-matching to optimize Cerenkov second harmonic generation. The modeling shows that a combination of phase-matching techniques creates larger conversion efficiencies and reduces critical fabrication requirements of the individual phase-matching techniques.

30374 (SAND-95-1060) **Evaluation of low-residue soldering for military and commercial applications: A report from the Low-Residue Soldering Task Force.** Iman, R.L. (Sandia National Labs., Albuquerque, NM (United States)); Anderson, D.J.; Burress, R.V. Sandia National Labs., Albuquerque, NM (United States). Jun 1995. 104p. Sponsored by USDOE, Washington, DC (United States). DOE Contract AC04-94AL85000. Order Number DE96000056. Source: OSTI; NTIS; GPO Dep.

The LRSTF combined the efforts of industry, military, and government to evaluate low-residue soldering processes for military and commercial applications. These processes were selected for evaluation because they provide a means for the military to support the presidential mandate while producing reliable hardware at a lower cost. This report presents the complete details and results of a testing program conducted by the LRSTF to evaluate low-residue soldering for printed wiring assemblies. A previous informal document provided details of the test plan used in this evaluation. Many of the details of that test plan are contained in this report. The test data are too massive to include in this report, however, these data are available on disk as Excel spreadsheets upon request. The main purpose of low-residue soldering is to eliminate waste streams during the manufacturing process.

30375 (SAND-95-1508C) **Embedded micromechanical devices for the monolithic integration of MEMS and CMOS.** Smith, J.H.; Montague, S.; Sniegowski, J.J.; McWhorter, P.J. Sandia National Labs., Albuquerque, NM (United States). [1995]. 4p. Sponsored by USDOE, Washington, DC (United States). DOE Contract AC04-94AL85000. (CONF-951213--1: 41. IEEE international electron devices meeting, Washington, DC (United States), 10-13 Dec 1995). Order Number DE95015091. Source: OSTI; NTIS; GPO Dep.

Short communication. MICROELECTRONIC CIRCUITS/ manufacturing; ACCELEROMETERS/manufacturing; MANUFACTURING; MOS TRANSISTORS; FABRICATION; ACTUATORS; ACCELEROMETERS; SIZE

30376 (SAND-95-1522C) **Photonics at Sandia National Laboratories: Applying device technology to communication systems.** Carson, R.F. Sandia National Labs., Albuquerque, NM (United States). [1995]. 6p. Sponsored by USDOE, Washington, DC (United States). DOE Contract AC04-94AL85000. (CONF-9511106--1: IEEE MILCOM 95: military communications, San Diego, CA (United States), 5-8 Nov 1995). Order Number DE95015060. Source: OSTI; NTIS; GPO Dep.

Photonic device activities at Sandia National Laboratories are founded on an extensive materials research program that has expanded to include device development, and an applications focus that heavily emphasizes communications and interconnects. The resulting program spans a full range of photonics research, development, and applications projects, from materials synthesis and device fabrication to packaging, test, and subsystem development. The heart of this effort is the Compound Semiconductor Research Laboratory which was established in 1988 to bring together device and materials research and development to support Sandia's role in weapons technologies. This paper presents an overview of Sandia's photonics program and its directions, using three communications-based applications as examples.

30377 (SAND–95-1885C) **Novel silicon fabrication process for high-aspect-ratio micromachined parts.** Fleming, J.G.; Barron, C.C. Sandia National Labs., Albuquerque, NM (United States). [1995]. 6p. Sponsored by USDOE, Washington, DC (United States). DOE Contract AC04-94AL85000. (CONF-9510196–1: 1995 Society of Photo-Optical Instrumentation Engineers (SPIE) meeting, Austin, TX (United States), 23-24 Oct 1995). Order Number DE95016761. Source: OSTI; NTIS; GPO Dep.

Bulk micromachining generally refers to processes involving wet chemical etching of structures formed out of the silicon substrate and so is limited to fairly large, crude structures. Surface micromachining allows intricate patterning of thin films of polysilicon and other materials to form essentially two-dimensional layered parts (since the thickness of the parts is limited by the thickness of the deposited films). There is a third type of micromachining in which the part is formed by filling a mold which was defined by photolithographic means. Historically micromachining molds have been formed in some sort of photopolymer, be it with x-ray lithography ("LIGA") or more conventional UV lithography, with the aim of producing piece parts. Recently, however, several groups including ours at Sandia have independently come up with the idea of forming the mold for mechanical parts by etching into the silicon substrate itself. In Sandia's mold process, the mold is recessed into the substrate using a deep silicon trench etch, lined with a sacrificial or etch-stop layer, and then filled with any of a number of mechanical materials. The completed structures are not ejected from the mold to be used as piece parts rather, the mold is dissolved from around selected movable segments of the parts, leaving the parts anchored to the substrate. Since the mold is recessed into the substrate, the whole micromechanical structure can be formed, planarized, and integrated with standard silicon microelectronic circuits before the release etch. In addition, unlike surface-micromachined parts, the thickness of the molded parts is limited by the depth of the trench etch (typically 10–50 μm) rather than the thickness of deposited polysilicon (typically 2 μm). The capability of fabricating thicker (and therefore much stiffer and more massive) parts is critical for motion-sensing structures involving large gimballed platforms, proof masses, etc.

30378 (SAND–95-1892C) **Surface micromachined sensors and actuators.** Sniegowski, J.J. Sandia National Labs., Albuquerque, NM (United States). [1995]. 10p. Sponsored by USDOE, Washington, DC (United States). DOE Contract AC04-94AL85000. (CONF-9510204–1: Micro-integrated smart materials and structures conference (MISMSC), Williamsburg, VA (United States), 11-12 Oct 1995). Order Number DE95016733. Source: OSTI; NTIS; GPO Dep.

A description of a three-level mechanical polysilicon surface-micromachining technology including a discussion of the advantages of this level of process complexity is presented. This technology is capable of forming mechanical elements ranging from simple cantilevered beams to complex, interconnected, interactive, microactuated micromechanisms. The inclusion of a third deposited layer of mechanical polysilicon greatly extends the degree of complexity available for micromechanism design. Additional features of the Sandia three-level process include the use of Chemical-Mechanical Polishing (CMP) for planarization, and the integration of micromechanics with the Sandia CMOS circuit process. The latter effort includes a CMOS-first, tungsten metallization process to allow the CMOS electronics to withstand high-temperature micromechanical processing. Alternatively, a novel micromechanics-first approach wherein the micromechanical devices are processed first in a well below the surface of the CMOS starting material followed by the standard, aluminum metallization CMOS process is also being pursued. Following the description of the polysilicon surface micromachining are examples of the major sensor and actuator projects based on this technology at the Microelectronics Development Laboratory (MDL) at Sandia National Laboratories. Efforts at the MDL are concentrated in the technology of surface micromachining due to the availability of and compatibility with standard CMOS processes. The primary sensors discussed are a silicon nitride membrane pressure sensor, hot polysilicon filaments for calorimetric gas sensing, and a smart hydrogen sensor. Examples of actuation mechanisms coupled to external devices are also presented. These actuators utilize the three-level process (plus an additional passive level) and employ either surface tension or electrostatic forces.

30379 (SAND–95-1937C) **Electrical biasing and voltage contrast imaging in a focused ion beam system.** Campbell, A.N. (Sandia National Labs., Albuquerque, NM (United States)); Soden, J.M.; Rife, J.L.; Lee, R.G. Sandia National Labs., Albuquerque, NM (United States). [1995]. 9p. Sponsored by USDOE, Washington, DC (United States). DOE Contract AC04-94AL85000. (CONF-951156–3: 21. international symposium for testing and failure analysis, Santa Clara, CA (United States), 5-10 Nov 1995). Order Number DE95017566. Source: OSTI; NTIS; GPO Dep.

We present two new techniques that enhance conventional focused ion beam (FIB) system capabilities for integrated circuit (IC) analysis: in situ electrical biasing and voltage contrast imaging. We have used in situ electrical biasing to enable a number of advanced failure analysis applications including (1) real time evaluation of device electrical behavior during milling and deposition, (2) verification of IC functional modifications without removal from the FIB system, and (3) ultraprecision control for cross sectioning of deep submicron structures, such as programmed amorphous silicon antifuses. We have also developed FIB system voltage contrast imaging that can be used for a variety of failure analysis applications. The use of passive voltage contrast imaging for defect localization and for navigation on planarized devices will be illustrated. In addition, we describe new, biased voltage contrast imaging techniques and provide examples of their application to the failure analysis of complex ICs. We discuss the necessary changes in system operating parameters to perform biased voltage contrast imaging.

30380 (SAND–95-1950) **Ultra-high-speed optical and electronic distributed devices.** Hietala, V.M.; Plut, T.A.; Kravitz, S.H.; Vawter, G.A.; Wendt, J.R.; Armendariz, M.G. Sandia National Labs., Albuquerque, NM (United States). Aug 1995. 45p. Sponsored by USDOE, Washington, DC (United States). DOE Contract AC04-94AL85000. Order Number DE96000700. Source: OSTI; NTIS; GPO Dep.

This report summarizes work on the development of ultra-high-speed semiconductor optical and electronic devices. High-speed operation is achieved by velocity matching the input stimulus to the output signal along the device's length. Electronic devices such as field-effect transistors (FET's), should experience significant speed increases by velocity matching the electrical input and output signals along the device. Likewise, optical devices, which are typically large, can obtain significant bandwidths by velocity matching the light being generated, detected or modulated with the electrical signal on the device's electrodes. The devices discussed in this report utilize truly distributed electrical design based on slow-wave propagation to achieve velocity matching.

30381 (SAND–95-2056C) **Fast and slow border traps in MOS devices.** Fleetwood, D.M. Sandia National Labs., Albuquerque, NM (United States). [1995]. 8p. Sponsored by USDOE, Washington, DC (United States);Defense Nuclear Agency, Washington, DC (United States). DOE Contract AC04-94AL85000. (CONF-9509107–2: 3. European symposium on radiations and their effects on components and systems, Arcachon (France), 18-22 Sep 1995). Order Number DE95017894. Source: OSTI; NTIS; GPO Dep.

Convergent lines of evidence are reviewed which show that near-interfacial oxide traps (border traps) that exchange charge with the Si can strongly affect the performance, radiation response, and long-term reliability of MOS devices. Observable effects of border traps include capacitance-voltage (C-V) hysteresis, enhanced 1/f noise, compensation of trapped holes, and increased thermally stimulated current in MOS capacitors. Effects of fast (switching times between $\sim 10^{-6}$ and 1 s) and slow (switching times greater than $\sim$ 1 s) border traps have been resolved via a dual-transistor technique. In conjunction with studies of MOS electrical response, electron paramagnetic resonance and spin dependent recombination studies suggest that different types of E′ defects (trivalent Si centers in SiO_2 associated with O vacancies) can function as border traps in MOS devices exposed to ionizing radiation or high-field stress. Hydrogen-related centers may also be border traps.

30382 (SAND–95-2058C) **Return to the shorted and shunted quartz gauge problem: Analysis with the SUBWAY code.** Montgomery, S.T.; Graham, R.A.; Anderson, M.U. Sandia National Labs., Albuquerque, NM (United States). [1995]. 5p. Sponsored by USDOE, Washington, DC (United States). DOE Contract AC04-94AL85000. (CONF-950846–57: American Physical Society biennial conference on shock compression of condensed matter, Seattle, WA (United States), 13-18 Aug 1995). Order Number DE95017895. Source: OSTI; NTIS; GPO Dep.

Simulations with finite element models of well controlled impact experiments with x-cut quartz gauges have been performed with the transient electromechanics code SUBWAY. Comparisons of measured gauge output current with calculated output current were made for four fully-electroded gauge configurations, involving two different can spacings and potting materials. The observed good agreement between measured and calculated currents provides a basis for confidence in the basic capabilities of the code.

30383 (SAND–95-2261C) **Deep x-ray lithography based processing for micromechanics.** Christenson, T.R. Sandia National Labs., Albuquerque, NM (United States). [1995]. 5p. Sponsored by USDOE, Washington, DC (United States);National Science Foundation, Washington, DC (United States);Department of Defense, Washington, DC (United States). DOE Contract AC04-94AL85000. NSF Grant ECS-9116566; DOD Contract ONR NOOO14093-1-0911. (CONF-951250–1: International semiconductor devices research symposium, Charlottsville, VA (United States), 6-8 Dec 1995). Order Number DE96000709. Source: OSTI; NTIS; GPO Dep.

Deep x-ray lithography based fabrication provides a means to fabricate microactuators with useful output forces. High energy x-ray exposure provides a tool for fabrication of the next generation of precision engineered components. Device characterization, materials science, an metrology continue to pose challenges at this scale.

30384 (SLAC-PUB–95-6835) **Alignment and magnet error tolerances for the LCLS x-ray FEL.** Nuhn, H.D. (Stanford Linear Accelerator Center, Menlo Park, CA (United States)); Scharlemann, E.T.; Schlueter, R. Stanford Linear Accelerator Center, Menlo Park, CA (United States); Lawrence Berkeley Lab., CA (United States). May 1995. 3p. Sponsored by USDOE, Washington, DC (United States). DOE Contract AC03-76SF00515 ; AC03-76SF00098. (CONF-950512–315: Particle accelerator conference, Dallas, TX (United States), 1-5 May 1995). Order Number DE95017722. Source: OSTI; NTIS; INIS; GPO Dep.

We have examined the influence of misalignments and magnet errors on the predicted performance of the Linac Coherent Light Source (LCLS). Due to the extremely large number of wiggler periods ($> 10^3$) and the small optical mode size (20 μm), alignment and magnet tolerances will be quite demanding. These demands may increase if the wiggler is split into separate sections by the possible inclusion of diagnostic stations, dispersive sections, etc. We have attempted to quantify such tolerances using the numerical simulation code FRED-3D.

30385 (UCRL-CR–120303) **Final report for 1.7 megajoule prototype bank testing.** Lawrence Livermore National Lab., CA (United States). [1995]. 150p. Sponsored by USDOE, Washington, DC (United States). DOE Contract W-7405-ENG-48. Subcontract B137125. Order Number DE96000355. Source: OSTI; NTIS; GPO Dep.

American Control Engineering is pleased to submit to LLNL this Final Report describing the final assembly and preliminary testing of the 1.7 megajoule prototype capacitor bank that is located at our facility. The purpose of this test program was to evaluate and characterize the performance of this capacitor bank. These tests were necessary in order to proceed with the design of a final building block module that is to be used to create a reliable and cost effective multi-hundred megajoule energy storage system. The period of performance covered by this contract is from January 1, 1991 through August 31, 1992. American Control Engineering has provided all of the necessary facilities, personnel and materials that were required to perform this testing effort (except for the existing capacitor bank, the LLNL provided flashlamp assembly and E-size ignitron switch tube), An overall view of the assembled capacitor bank system as it appeared at the completion of this subcontract is shown. The initial statement-of-work for the testing and characterization of the capacitor bank was as follows: (1) Measure all of the principal electrical parameters for the 1.7 megajoule prototype capacitor bank at low voltage before proceeding to high voltage testing. This low voltage testing is to include measurement of both normal and fault current and voltage waveforms, starting with the smallest building block grouping and proceeding systematically through to the capacitor bank load. (2) Assemble and attach each of the major subsystem elements to the capacitor bank as they are required for low voltage testing including the ignition output switch structure, coaxial transmission line and load assembly. (3) Make comparison of the test results collected through low voltage testing with those forecasted by the computer mode. Evaluate and resolve any discrepancies between the two results until the computer model achieves reasonable agreement with the actual measured test results.

30386 (UCRL-CR–121458) **Theoretical description of laser melt pool dynamics, Task order number B239634, Quarter 3 report.** Dykhne, A. Lawrence Livermore National Lab., CA (United States). 10 May 1995. 38p. Sponsored by USDOE, Washington, DC (United States). DOE Contract W-7405-ENG-48. Order Number DE95017254. Source: OSTI; NTIS; GPO Dep.

Melting of solid matter under laser radiation is realized in almost every process of laser technology. The present paper addresses melted material flows in cases when melt zones are shallow, i.e., the zone width is appreciably greater than or of the same order as its depth. Such conditions are usually realized when hardening, doping or perforating thin plates or when using none-deep penetration. Melted material flowing under conditions of deep penetration, drilling of deep openings and cutting depends on a number of additional factors (as compared to the shallow-pool case), namely, formation of a vapor and gas cavern in the sample and propagation of the laser beam through the cavern. These extra circumstances complicate hydrodynamic consideration of the liquid bath and will be addressed is the paper to follow.

30387 (UCRL-ID–119535-5) **Joint UK/US Radar Program. Progress reports, March 1, 1995–March 31, 1995.** Kiefer, R. (and others); Brase, J.; Mantrom, D. Lawrence Livermore National Lab., CA (United States). 24 Apr 1995. 21p. Sponsored by USDOE, Washington, DC (United States). DOE Contract W-7405-ENG-48. Order Number DE95017883. Source: OSTI; NTIS; GPO Dep.

This report details the research programs on radar, between the United States and the United Kingdom.

30388 (UCRL-JC–118103) **Generation of x-ray pulses with rapid rise times to pump inner-shell photo-ionized x-ray lasing in carbon at 45 Å.** Moon, S.J.; Eder, D.C. Lawrence Livermore National Lab., CA (United States). 28 Jul 1995. 6p. Sponsored by USDOE, Washington, DC (United States). DOE Contract W-7405-ENG-48. (CONF-950793–40: 40. annual meeting of the Society of Photo-Optical Instrumentation Engineers, San Diego, CA (United States), 9-14 Jul 1995). Order Number DE96000337. Source: OSTI; NTIS; INIS; GPO Dep.

An investigation of the rapid rise time of x-ray emission from targets heated by an ultrashort-pulse high-intensity optical laser was conducted for use as a pump for inner-shell photo-ionized x-ray lasing. Results of x-ray rise times from instantaneously heated Au rod targets show little benefit for using optical pulse widths less than 30 fs. Gain calculations for inner-shell photo-ionized lasing show that large gains can be obtained for pulse widths between 30 and 100 fs. Calculated spectra, using the hydrodynamic/atomic kinetics code LASNEX, from a 1 J, 65 fs FWHM pulse optical laser incident on a structured Au target gave a gain of 1 1.5 cm^{-1} in C at 45 Å.

30389 (UCRL-JC–118194) **Diode-pumped $Yb:Sr_5(PO_4)_3F$ laser performance.** Marshall, C.D. (and others); Payne, S.A.; Smith, L.K. Lawrence Livermore National Lab., CA (United States). 17 Mar 1995. 5p. Sponsored by USDOE, Washington, DC (United States). DOE Contract W-7405-ENG-48. (CONF-950101–9: Advanced solid-state laser conference, Memphis, TN (United States), 29 Jan - 1 feb 1995). Order Number DE96000096. Source: OSTI; NTIS; INIS; GPO Dep.

The performance of the first diode-pumped Yb^{3+}-doped $Sr_5(PO_4)_3F$ (Yb:S-FAP) laser is discussed. We found the pumping dynamics and extraction cross-sections of Yb:S-FAP crystals to be similar to those previously inferred by purely spectroscopic techniques. The saturation fluence for pumping was measured to be 2.2 J/cm^2 using three different methods based on either the spatial, temporal, or energy transmission properties of a Yb:S-FAP rod. The small signal gain implies an emission cross section of 6.0 x 10^{-20} cm^2 that falls within error bars of the previously reported value of 7.3 x 10^{-20} cm^2, obtained from spectroscopic techniques. Up to 1.7 J/cm^3 of stored energy density was achieved in a 6 x 6 x 44 mm Yb:S-FAP amplifier rod. An InGaAs diode array has been fabricated that has suitable specifications for pumping a 3 x 3 x 30 mm Yb:S-FAP rod. In a free running configuration diode-pumped slope efficiencies up to 43% were observed with output energies up to ~0.5 J per 1 ms pulse. When the rod was mounted in a copper block for cooling, 13 W of average power was produced with power supply limited operation at 70 Hz and 500 μs pulses.

30390 (UCRL-JC–119362) **Integrated power conditioning for laser diode arrays.** Hanks, R.L.; Kirbie, H.C.; Newton, M.A.; Farhoud, M.S. Lawrence Livermore National Lab., CA (United States). 30 Jun 1995. 13p. Sponsored by USDOE, Washington, DC (United States). DOE Contract W-7405-ENG-48. (CONF-950750–33: 10. Institute of Electrical and Electronics Engineers (IEEE) pulsed power conference, Albuquerque, NM (United States), 10-13 Jul 1995). Order Number DE95015980. Source: OSTI; NTIS; INIS; GPO Dep.

This compact modulator has demonstated its ability to efficiently and accurately drive a laser diode array. The addition of the crowbar protection circuit is an invaluable addition to the integrated system and is capable of protecting the laser diode array against severe damage. We showed that the correlation between measured data and simulation indicates that our modulator model is valid and can be used as a tool in the design of future systems. The spectrometer measurements that we conducted underline the imprtance of current regulation to stable laser operation.

30391 (UCRL-JC–120187-Rev.1) **Laser induced damage in multilayer dielectric gratings due to ultrashort laser pulses. Revision 1.** Shore, B.W.; Stuart, B.C.; Feit, M.D.; Rubenchik, A.M.; Perry, M.D. Lawrence Livermore National Lab., CA (United States). 11 Jul 1995. 9p. Sponsored by USDOE, Washington, DC (United States). DOE Contract W-7405-ENG-48. (CONF-9505264–25-Rev.1: 1. annual solid-state lasers for application to inertial confinement fusion meeting, Monterey, CA (United States), 30 May - 2 jun 1995). Order Number DE96000098. Source: OSTI; NTIS; INIS; GPO Dep.

Chirped pulse amplification is increasingly used to produce intense ultrashort laser pulses. When high-efficiency gratings are the dispersive element, as in the LLNL Petawatt laser, their susceptibility to laser induced damage constitutes a limitation on the peak intensities that can be reached. To obtain robust gratings, it is necessary to understand the causes of short-pulse damage, and to recognize the range of design options for high efficiency gratings. Metal gratings owe their high efficiency to their high conductivity. To avoid the inevitable light absorption that accompanies conductivity, we have developed designs for high efficiency rejection gratings that use only transparent dielectric materials. These combine the reflectivity of a multi-layer dielectric stack with a diffraction grating. We report here our present understanding of short-pulse laser induced damage, as it applies to dielectric gratings.

30392 (UCRL-JC–120640) **Silicon microbench heater elements for packaging opto-electronic devices.** Combs, R.; Keiser, P.; Kleint, K.; Pocha, M.; Patterson, F.; Strand, O.T. Lawrence Livermore National Lab., CA (United States). Sep 1995. 10p. Sponsored by USDOE, Washington, DC (United States). DOE Contract W-7405-ENG-48. (CONF-9510189–2: SPIE conference on photonic sensors and controls for commercial applications (Photonics East), Philadelphia, PA (United States), 22-26 Oct 1995). Order Number DE96000417. Source: OSTI; NTIS; GPO Dep.

Examples are presented of the application of Lawrence Livermore National Laboratory's expertise in photonics packaging. Several examples of packaged devices will be described. Particular attention is given to silicon microbenches incorporating heaters and their use in semiconductor optical amplifier fiber pigtailing and packaging.

30393 (UCRL-JC–120920) **Specification of optical components using the power spectral density function.** Lawson, J.K.; Wolfe, C.R.; Manes, K.R.; Trenholme, J.B.; Aikens, D.M.; English, R.E. Jr. Lawrence Livermore National Lab., CA (United States). 20 Jun 1995. 15p. Sponsored by USDOE, Washington, DC (United States). DOE Contract W-7405-ENG-48. (CONF-950793–42: 40. annual meeting of the Society of Photo-Optical Instrumentation Engineers, San Diego, CA (United States), 9-14 Jul 1995). Order Number DE96000260. Source: OSTI; NTIS; GPO Dep.

This paper describes the use of Fourier techniques to characterize the wavefront of optical components, specifically, the use of the power spectral density, (PSD), function. The PSDs of several precision optical components will be shown. Many of the optical components of interest to us have square, rectangular or irregularly shaped apertures with major dimensions up-to 800 mm. The wavefronts of components with non-circular apertures cannot be analyzed with Zernicke polynomials since these functions are an orthogonal set for circular apertures only. Furthermore, Zernicke analysis is limited to treating low frequency wavefront aberrations; mid-spatial scale and high frequency error are expressed only as "residuals." A more complete and powerful representation of the optical wavefront can be obtained by Fourier analysis in 1 or 2 dimensions. The PSD is obtained from the amplitude of frequency components present in the Fourier spectrum. The PSD corresponds to the scattered intensity as a function of scattering angle in the wavefront and can be used to describe the intensity distribution at focus. The shape of a resultant wavefront or the focal spot of a complex multi-component laser system can be calculated and optimized using the PSDs of individual optical components which comprise it.

30394 (UCRL-JC–121614) **Diode-pumped solid-state laser driver experiments for inertial fusion energy applications.** Marshall, C.D.; Payne, S.A.; Emanuel, M.E.; Smith, L.K.; Powell, H.T.; Krupke, W.F. Lawrence Livermore National Lab., CA (United States). 11 Jul 1995. 10p. Sponsored by USDOE, Washington, DC (United States). DOE Contract W-7405-ENG-48. (CONF-9505264–28: 1. annual solid-state lasers for application to inertial confinement fusion meeting, Monterey, CA (United States), 30 May - 2 jun 1995). Order Number DE96000095. Source: OSTI; NTIS; INIS; GPO Dep.

Although solid-state lasers have been the primary means by which the physics of inertial confinement fusion (ICF) have been investigated, it was previously thought that solid-state laser technology could not offer adequate efficiencies for an inertial fusion energy (IFE) power plant. Orth and co-workers have recently designed a conceptual IFE power plant, however, with a high efficiency diode-pumped solid-state laser (DPSSL) driver that utilized several recent innovations in laser technology. It was concluded that DPSSLs could offer adequate performance for IFE with reasonable assumptions. This system was based on a novel diode pumped Yb-doped $Sr_5(PO_4)_3F$ (Yb:S-FAP) amplifier. Because this is a relatively new gain medium, a project was established to experimentally validate the diode-pumping and extraction dynamics of this system at the smallest reasonable scale. This paper reports on the initial experimental results of this study. We found the pumping dynamics and extraction cross-sections of Yb:S-FAP crystals to be similar to those previously inferred by purely spectroscopic techniques. The saturation fluence for pumping was measured to be 2.2 J/cm^2 using three different methods based on either the spatial, temporal, or energy transmission properties of a Yb:S-FAP rod. The small signal gain implies an emission cross section of 6.0×10^{-20} cm^2. Up to 1.7 J/cm^3 of stored energy density was achieved in a $6 \times 6 \times 44$ mm^3 Yb:S-FAP amplifier rod. In a free running configuration diode-pumped slope efficiencies up to 43% were observed with output energies up to ~0.5 J per 1 ms pulse from a $3 \times 3 \times 30$ mm^3 rod. When the rod was mounted in a copper block for cooling, 13 W of average power was produced with power supply limited operation at 70 Hz with 500 μs pulses.

30395 (UCRL-JC–121626) **High-power copper vapour lasers and applications.** Chang, J.J.; Warner, B.E.; Boley, C.D.; Dragon, E.P. Lawrence Livermore National Lab., CA (United

States). Aug 1995. 15p. Sponsored by USDOE, Washington, DC (United States). DOE Contract W-7405-ENG-48. (CONF-9508168–1: NATO advanced research workshop on pulsed metal vapor lasers, St. Andrews (United Kingdom), 7-11 Aug 1995). Order Number DE95017864. Source: OSTI; NTIS; GPO Dep.

Expanded applications of copper vapor lasers has prompted increased demand for higher power and better beam quality. This paper reports recent progress in laser power scaling, MOPA operation, beam quality improvement, and applications in precision laser machining. Issues such as gas heating, radial delay, discharge instability, and window heating will also be discussed.

30396 (UCRL-JC–121646) **New solid state lasers from the ultraviolet to the mid-infrared.** Payne, S.A. (and others); Krupke, W.F.; Beach, R.J. Lawrence Livermore National Lab., CA (United States). 15 Aug 1995. 6p. Sponsored by USDOE, Washington, DC (United States). DOE Contract W-7405-ENG-48. (CONF-950401–27: 97. annual meeting of the American Ceramic Society, Cincinnati, OH (United States), 30 Apr - 1 may 1995). Order Number DE96000345. Source: OSTI; NTIS; INIS; GPO Dep.

The authors discuss three new laser materials that offer improved access to the ultraviolet, near infrared and mid-infrared spectral regions. In order for each of these materials to have been identified, a particular hurdle needed to be overcome with respect to the fundamental laser physics impacting the material. In the case of the 280-320nm Ce:LiSAF laser, the main issue is the need to reduce the loss associated with excited state absorption, while for 1047nm Yb:S-FAP it is the ground state absorption at the laser wavelength that must be minimized. Cr:ZnSe has been down-selected from a number of potential candidates which could lase in the 2200-3000nm region, in order to mitigate the detrimental impact of nonradiative decay. In all three cases the authors discuss how appropriate consideration of fundamental concerns has led to the identification and understanding of the new laser system.

43 PARTICLE ACCELERATORS

Refer also to citation(s) 30359, 30360, 30366

30397 (BNL–52292-Vol.4) **Selected topics in particle accelerators: Proceedings of the CAP meetings. Volume 4.** Parsa, Z. (ed.) (comp.). Brookhaven National Lab., Upton, NY (United States). [1995]. 348p. Sponsored by USDOE, Washington, DC (United States). DOE Contract AC02-76CH00016. (CAP–124-95P). Order Number DE96000893. Source: OSTI; NTIS; INIS; GPO Dep. Viewgraphs.

This Report includes copies of transparencies and notes from the presentations made at the Center for Accelerator Physics at Brookhaven National Laboratory. Editing and changes to the authors' contributions in this Report were made only to fulfill the publication requirements. This volume includes notes and transparencies on eight presentations: "Application of Accelerator-Driven Spallation Targets - Including Tritium Production and Nuclear Waste Transmutation", "BNL 5 MW Pulsed Spallation Neutron Source Study", "Designing and Understanding of Magnets with the Help of Conformal Mapping", "Laser - Electron Beam Scattering Coherent Compton X-Ray Sources", "The LHC Project", "Optimization of the Photocathode-Linac Separation for the ATF [Accelerator Test Facility] Injection System", "On CEBAF Commissioning: First Results", and "The Proposed Booster Application Facility at BNL". An Appendix lists dates, topics, and speakers from October 1989 to December 1994.

30398 (DOE/ER/40853–4) **Research in accelerator physics (theory). Technical progress report, March 11–August 31, 1995.** Ohnuma, Shoroku. Houston Univ., TX (United States). 1 Sep 1995. 5p. Sponsored by USDOE, Washington, DC (United States). DOE Contract FG03-94ER40853. Order Number DE96000443. Source: OSTI; NTIS; INIS; GPO Dep.

A brief description of the present status, expected effort during the remainder of the period of the project, and some of the main results for the work is presented here. The project covered the following areas of research: (1) tune modulation; (2) multi-parameter sorting of dipoles for large superconducting rings; and integrable polynomial factorization for symplectic map tracking.

30399 (JAERI-Conf–95-017) **The 1st workshop on utilization of high intensity proton accelerator.** Mizumoto, Motoharu (Japan Atomic Energy Research Inst., Tokai, Ibaraki (Japan). Tokai Research Establishment); Tanaka, Shun-ichi (eds.). Japan Atomic Energy Research Inst., Tokyo (Japan). Sep 1995. 229p. (In Japanese, English). (CONF-9502123–: 1. workshop on utilization of high intensity proton accelerator, Tokai (Japan), 7-8 Feb 1995). Order Number DE96701438. Source: OSTI; NTIS; INIS.

This issue is the collection of the papers presented at the title meeting. The 23 of the presented papers are indexed individually. (J.P.N.).

30400 (LBL–37231) **Center for Beam Physics: 1994–95.** Lawrence Berkeley Lab., CA (United States). May 1995. 83p. Sponsored by USDOE, Washington, DC (United States). DOE Contract AC03-76SF00098. Order Number DE96000147. Source: OSTI; NTIS; INIS; GPO Dep.

The Center for Beam Physics is a multidisciplinary research and development unit in the Accelerator and Fusion Research Division at the Lawrence Berkeley Laboratory of the University of California. At the heart of the Center's mission is a fundamental quest for mechanisms of acceleration, radiation, transport, and focusing of energy and information. Dedicated to exploring the frontiers of particle and photon beam physics, its primary mission is to promote the science and technology of the production, manipulation, storage, and control of systems of charged particles and photons. This roster and annual report provides a glimpse of the scientists, engineers, technical support, students, and administrative staff that make up the CBP's team and gives a brief review of the multifaceted activities during 1994 and 1995.

4301 Design, Development, and Operation

Refer also to citation(s) 28875, 28876, 28878, 28882, 28888, 29127, 29130, 29131, 29173, 29542, 29549, 29561, 30298, 30359, 30360, 30397, 30461, 30801, 31052, 31240, 31251, 31253, 31279, 31354

30401 (BNL–62173) **NSLS source development laboratory.** Ben-Zvi, I. (and others); Blum, E.; Johnson, E.D. Brookhaven National Lab., Upton, NY (United States). [1995]. 8p. Sponsored by USDOE, Washington, DC (United States). DOE Contract AC02-76CH00016. (CONF-9507178–1: SPIE electron beam sources of high-brightness radiation, San Diego, CA (United States), 9-14 Jul 1995). Order Number DE95017890. Source: OSTI; NTIS; INIS; GPO Dep.

The National Synchrotron Light Source (NSLS) has initiated an ambitious project to develop fourth generation radiation sources. To achieve this goal, the Source Development Laboratory (SDL) builds on the experience gained at the NSLS, and at the highly successful BNL Accelerator Test Facility. The SDL accelerator system will consist of a high brightness short pulse linac, a station for coherent synchrotron and transition radiation experiments, a short bunch storage ring, and an ultra-violet free electron laser utilizing the NISUS wiggler. The electrons will be provided by a laser photocathode gun feeding a 210 MeV S-band electron linac, with magnetic bunch compression at 80 MeV. Electron bunches as short as 100 μm with 1 nC charge will be used for pump-probe experiments utilizing coherent transition radiation. Beam will also be injected into a compact storage ring which will be a source of millimeter wave coherent synchrotron radiation. The linac will also serve as the driver for an FEL designed to allow the study of various aspects of single pass amplifiers. The first FEL configuration will be as a self-amplified spontaneous emission (SASE) FEL at 900 nm. Seeded beam and sub-harmonic seeded beam operations will push the output wavelength below 200 nm. Chirped pulse amplification (CPA) operation will also be possible, and a planned energy upgrade (by powering a fifth linac section) to 310 MeV will extend the wavelength range of the FEL to below 100 nm.

30402 (IFVE-OKU–94-30) **Conservation of proton beam polarization during acceleration in U-70.** Ado, Yu.M.; Anferov, V.A.; Shumkin, D.S. Gosudarstvennyj Komitet po Ispol'zovaniyu Atomnoj Ehnergii SSSR, Serpukhov (Russian Federation). Inst. Fiziki

Vysokikh Ehnergij. 1994. 16p. (In Russian). Order Number DE96601945. Source: OSTI; NTIS (US Sales Only); INIS.

The paper considers possibility to accelerate polarized beam in the IHEP proton synchrotron. It is suggested to use one helical Siberian snake and pair of pulsed quadrupoles. which are necessary at the beginning of the accelerator cycle. In this scheme the snake is turned on adiabatically during accelerator cycle at 10 GeV. To incorporate snake into the accelerator lattice it is proposed to make modification of one superperiod. This would allow to make a 13 m long straight section. 11 refs.; 5 figs.; 3 tabs.

30403 (LA-UR–95-3018) **High brightness beams and applications.** Sheffield, R.L. Los Alamos National Lab., NM (United States). [1995]. 40p. Sponsored by USDOE, Washington, DC (United States). DOE Contract W-7405-ENG-36. (CONF-9505285–1: Workshop on development and applications of free electron lasers, Beijing (China), 20 May - 6 jun 1995). Order Number DE96000039. Source: OSTI; NTIS; INIS; GPO Dep.

This paper describes the present research on attaining intense bright electron beams. Thermionic systems are briefly covered. Recent and past results from the photoinjector programs are given. The performance advantages and difficulties presently faced by researchers using photoinjectors is discussed. The progress that has been made in photocathode materials, both in lifetime and quantum efficiency, is covered. Finally, a discussion of emittance measurements of photoinjector systems and how the measurement is complicated by the non-thermal nature of the electron beam is presented.

30404 (LA-UR–95-17922, pp. 176-185) **Los Alamos high-power proton linac designs.** Lawrence, G.P. (Los Alamos National Laboratory, NM (United States)). Los Alamos National Lab., NM (United States). [1995]. (CONF-9407103–: International conference on accelerator-driven transmutation technologies and applications, Las Vegas, NV (United States), 25 Jul - 1 aug 1994). In *AIP conference on accelerator driven transmutation technologies and applications, Los Vegas, Nevada, July 25-29, 1994*. 958p. Order Number DE95014018. Source: OSTI; NTIS; INIS.

Medium-energy high-power proton linear accelerators have been studied at Los Alamos as drivers for spallation neutron applications requiring large amounts of beam power. Reference designs for such accelerators are discussed, important design factors are reviewed, and issues and concern specific to this unprecedented power regime are discussed.

30405 (LA-UR–95-17922, pp. 186-199) **Linac design for the European spallation source.** Klein, H. (Universitaet Postfach, Frankfurt am Main (Germany)). Los Alamos National Lab., NM (United States). [1995]. (CONF-9407103–: International conference on accelerator-driven transmutation technologies and applications, Las Vegas, NV (United States), 25 Jul - 1 aug 1994). In *AIP conference on accelerator driven transmutation technologies and applications, Los Vegas, Nevada, July 25-29, 1994*. 958p. Order Number DE95014018. Source: OSTI; NTIS; INIS.

A study group has started to develop a conceptual design for a European Spallation Source (ESS). This pulsed 5 MW source presently consists of a 1.334 GeV linac and two compressor rings. In the following mainly the high intensity linac part will be discussed, which has some features of interest for accelerators for transmutation of radioactive waste too.

30406 (LA-UR–95-17922, pp. 200-207) **Design of high-energy high-current linac with focusing by superconducting solenoids.** Batskikh, G.I. (Moscow Radiotechnical Institute (Russian Federation)); Belugin, V.M.; Bondarev, B.I. Los Alamos National Lab., NM (United States). [1995]. (CONF-9407103–: International conference on accelerator-driven transmutation technologies and applications, Las Vegas, NV (United States), 25 Jul - 1 aug 1994). In *AIP conference on accelerator driven transmutation technologies and applications, Los Vegas, Nevada, July 25-29, 1994*. 958p. Order Number DE95014018. Source: OSTI; NTIS; INIS.

The advancement of MRTI design for 1.5 GeV and 250 mA ion CW linac was presented in a previous report. In this new linac version all the way from input to output the ions are focused by magnetic fields of superconducting solenoids. The ion limit current is far beyond the needed value. The linac focusing channel offers major advantages over the more conventional ones. The acceptance is 1.7 times as large for such focusing channel as for quadrupole one. Concurrently, a random perturbation sensitivity for such channel is one order of magnitude smaller than in quadrupole channel. These focusing channel features allow to decrease beam matched radius and increase a linac radiation purity without aperture growth. "Regotron" is used as high power generator in linac main part. But D&W cavities need not be divided into sections connected by RF-bridges which denuded them of high coupling factor.

30407 (LA-UR–95-17922, pp. 208-217) **Cost optimisation studies of high power accelerators.** McAdams, R. (AEA Technology, Oxon (United Kingdom)); Nightingale, M.P.S.; Godden, D. Los Alamos National Lab., NM (United States). [1995]. (CONF-9407103–: International conference on accelerator-driven transmutation technologies and applications, Las Vegas, NV (United States), 25 Jul - 1 aug 1994). In *AIP conference on accelerator driven transmutation technologies and applications, Los Vegas, Nevada, July 25-29, 1994*. 958p. Order Number DE95014018. Source: OSTI; NTIS; INIS.

Cost optimisation studies are carried out for an accelerator based neutron source consisting of a series of linear accelerators. The characteristics of the lowest cost design for a given beam current and energy machine such as power and length are found to depend on the lifetime envisaged for it. For a fixed neutron yield it is preferable to have a low current, high energy machine. The benefits of superconducting technology are also investigated. A Separated Orbit Cyclotron (SOC) has the potential to reduce capital and operating costs and intial estimates for the transverse and longitudinal current limits of such machines are made.

30408 (LA-UR–95-17922, pp. 228-234) **Potential of cyclotron based accelerators for energy production and transmutation.** Stammbach, T. (Paul Scherrer Institute, Villigen (Switzerland)); Adam, S.; Fitze, H.R. Los Alamos National Lab., NM (United States). [1995]. (CONF-9407103–: International conference on accelerator-driven transmutation technologies and applications, Las Vegas, NV (United States), 25 Jul - 1 aug 1994). In *AIP conference on accelerator driven transmutation technologies and applications, Los Vegas, Nevada, July 25-29, 1994*. 958p. Order Number DE95014018. Source: OSTI; NTIS; INIS.

PSI operates a 590 MeV-cyclotron facility for high intensity proton beams for the production of intense beams of pions and muons. The facility, commissioned in 1974, has been partially upgraded and is now operated routinely at a beam current of 1 mA, which corresponds to a beam power of 0.6 MW. At this current, the beam losses in the cyclotron are about 0.02%. By the end of 1995 the authors expect to have 1.5 mA of protons. Extensive theoretical investigations on beam current limitations in isochronous cyclotrons were undertaken. They show that the longitudinal space charge effects dominate. Based on their experience the authors present a preliminary design of a cyclotron scheme that could produce a 10 MW beam as a driver for an "energy amplifier" as proposed by C. Rubbia and his collaborators. The expected efficiency for the conversion of AC into beam power would be about 50% (for the RF-systems only). The beam losses in the cyclotron are expected to be a few μA, leading to a tolerable activation level.

30409 (LA-UR–95-17922, pp. 403-409) **HILBILAC development for accelerator-driven transmutation.** Pirozhenko, V. (Moscow Radiotechnical Institute (Russian Federation)); Plink, O. Los Alamos National Lab., NM (United States). [1995]. (CONF-9407103–: International conference on accelerator-driven transmutation technologies and applications, Las Vegas, NV (United States), 25 Jul - 1 aug 1994). In *AIP conference on accelerator driven transmutation technologies and applications, Los Vegas, Nevada, July 25-29, 1994*. 958p. Order Number DE95014018. Source: OSTI; NTIS; INIS.

High-Intensity Low-Beta Ion Linac (HILBILAC) is intended for acceleration of ion beams with current of about 1 A and higher. The CW HILBILAC with beam current of 2l50 mA is under development at MRTI. Concept of parameters choice is presented along with results of beam dynamics and resonator parameters calculations. A pulse prototype HILBILAC-TEST will have to be constructed and

tested for the CW accelerator development, its scheme and parameters are presented.

30410 (LA-UR–95-17922, pp. 578) **RAMI analysis and modeling for the LANSCE accelerator systems.** Macek, R.J. (Los Alamos National Laboratory, NM (United States)); Wilkinson, C.A. Los Alamos National Lab., NM (United States). [1995]. (CONF-9407103–: International conference on accelerator-driven transmutation technologies and applications, Las Vegas, NV (United States), 25 Jul - 1 aug 1994). In *AIP conference on accelerator driven transmutation technologies and applications, Los Vegas, Nevada, July 25-29, 1994.* 958p. Order Number DE95014018. Source: OSTI; NTIS; INIS.

Reliability, availability, maintainability, and inspectability (RAMI) have become important issues for the high-power machines being planned for applications such as accelerator transmutation of nuclear waste (ATW), accelerator production of tritium (APT) and the next generation spallation neutron source. Beam reliability and beam availability are vitally important specifications to the present users of accelerator-driven spallation neutron sources, synchrotron light sources and medical accelerators. At Los Alamos, improved beam availability is a key goal in the planned LANSCE improvement program. Clearly, the capability to adequately model and predict the reliability and availability of complex accelerator systems will be of great value in assessing and optimizing RAMI measures in accelerator design and improvement programs. To date, no major accelerator project has developed comprehensive reliability models although the Advance Photon Source at ANL has started work on reliability analysis for selected subsystems. In this paper the authors discuss their experience in developing RAMI analysis and modeling for the LANSCE Accelerator Systems. Progress has been made in developing suitable measures and functions to characterize user risk, in logging of needed data on failure rates and repair/down times, and in developing a first-pass RAMI model for selected subsystems. Plans have been made for a more complete RAMI model. In addition, the authors discuss their experience in the use of probabilistic risk assessment (PRA) methodology for estimation of the reliability of active, instrumentation-based, radiation safety systems at LANSCE.

30411 (LA-UR–95-17922, pp. 936-938) **Summary of the Accelerator-Driven Transmutation Technologies and their applications.** Wanger, T.P. Los Alamos National Lab., NM (United States). [1995]. (CONF-9407103–: International conference on accelerator-driven transmutation technologies and applications, Las Vegas, NV (United States), 25 Jul - 1 aug 1994). In *AIP conference on accelerator driven transmutation technologies and applications, Los Vegas, Nevada, July 25-29, 1994.* 958p. Order Number DE95014018. Source: OSTI; NTIS; INIS.

During the past 15 years many advances have been made in the technology of high-power accelerators, and in the understanding of the beam-physics issues associated with their high-performance requirements. These developments have contributed significantly to the high level of confidence in the practicality of the applications that were the central point of the international Accelerator-Driven Transmutation Technologies (ADTT) Conference. Even so, there are many accelerator topics that needed to be addressed, and the Conference provided the opportunity to address these issues.

30412 (LBL–37301) **Status of the SLAC/LBL/LLNL B-Factory and the BaBar detector.** Oddone, P. (Lawrence Berkeley Lab., CA (United States). Physics Div.). Lawrence Berkeley Lab., CA (United States). Aug 1994. 18p. Sponsored by USDOE, Washington, DC (United States). DOE Contract AC03-76SF00098. (CONF-9408217–3: 1. Arctic workshop on future physics and accelerators, Saariselka (Finland), 21-26 Aug 1994). Order Number DE96000129. Source: OSTI; NTIS; INIS; GPO Dep.

The primary motivation of the Asymmetric B-Factory is the study of CP violation. The decay of B mesons and, in particular, the decay of neutral B mesons, offers the possibility of determining conclusively whether CP violation is part and parcel of the Standard Model with three generations of quarks and leptons. Alternatively, the authors may discover that CP violation lies outside the present framework. In this paper the authors briefly describe the physics reach of the SLAC/LBL/LLNL Asymmetric B-Factory, the progress on the machine design and construction, the progress on the detector design, and the schedule to complete both projects.

30413 (SLAC-PUB–95-6757) **The PEP-II design.** Sullivan, M.K. (California Univ., Stanford, CA (United States). Intercampus Inst. for Research at Particle Accelerators). Stanford Linear Accelerator Center, Menlo Park, CA (United States); California Univ., Stanford, CA (United States). Intercampus Inst. for Research at Particle Accelerators. May 1995. 10p. Sponsored by USDOE, Washington, DC (United States). DOE Contract AC03-76SF00515 ; AS03-76ER70285. (CONF-9410248–4: 1994 international workshop on B physics, physics beyond the standard model at the B factory, Nagoya (Japan), 26-28 Oct 1994). Order Number DE95017717. Source: OSTI; NTIS; INIS; GPO Dep.

The Stanford Linear Accelerator Center (SLAC), Lawrence Berkeley Laboratory (LBL), Lawrence Livermore National Laboratory (LLNL) Positron Electron Project-II (PEP-II) is a design for a high-luminosity, asymmetric energy, electron-positron colliding beam accelerator that will operate at the center-of-mass energy of the Y4S (10.58 GeV). The goal of the design is to achieve a large enough integrated luminosity with a moving center-of-mass reference frame to he able to observe the predicted rare decay modes of the Y4S that do not conserve charge parity (CP).

30414 (SSCL-SR–1222) **ESNET requirements for physics research at the SSCL.** Cormell, L.; Johnson, T. Superconducting Super Collider Lab., Dallas, TX (United States). Jun 1993. 5p. Sponsored by USDOE, Washington, DC (United States). DOE Contract AC35-89ER40486. Order Number DE95011789. Source: OSTI; NTIS; INIS; GPO Dep.

High energy physics (HEP) research at the Superconducting Super Collider Laboratory (SSCL) is a highly collaborative affair. Scientists participating in SSC research come from a worldwide distribution of institutions. The Solenoid Detector Collaboration (SDC) currently has more than 1100 members from 20 countries. Likewise, the Gamma, Electron, Muon (GEM) collaboration members number more than 1000 from 17 countries. Roughly half of the collaborators on these experiments are from outside the US Communications, in general, and data transmission, in particular, are crucial to the success of the collaborations and to the ultimate success of the SSC. The bulk of data transmission to and from the Laboratory is over the Energy Science NETwork (ESNET). The purpose of this document is to describe the anticipated network capacity needed to provide adequate communication among these widespread collaborations.

30415 (SSC-SR–1026) **SSC environmental radiation shielding.** Jackson, J.D. (ed.). Lawrence Berkeley Lab., CA (United States). SSC Central Design Group. 1 Jul 1987. 103p. Sponsored by USDOE, Washington, DC (United States). DOE Contract AC35-89ER40486. Order Number DE95011088. Source: OSTI; NTIS; GPO Dep.

The environmental radiation shielding requirements of the SSC have been evaluated using currently available computational tools that incorporate the well known processes of energy loss and degradation of high energy particles into Monte Carlo computer codes. These tools permit determination of isodose contours in the matter surrounding a source point and therefore the specification of minimum thicknesses or extents of shielding in order to assure annual dose equivalents less than some specified design amount. For the general public the annual dose equivalent specified in the design is 10 millirem, small compared to the dose from naturally occurring radiation. The types of radiation fall into two classes for the purposes of shielding determinations-hadrons and muons. The sources of radiation at the SSC of concern for the surrounding environment are the interaction regions, the specially designed beam dumps into which the beams are dumped from time to time, and beam clean-up regions where stops remove the beam halo in order to reduce experimental backgrounds. A final, unlikely source of radiation considered is the accidental loss of the full beam at some point around the ring. Conservative choices of a luminosity of 10^{34} $cm^{-2}s^{-1}$ and a beam current three times design have been made in calculating the required shielding and boundaries of the facility. In addition to determination of minimum distances for the annual dose equivalents, the question of possible radioactivity produced in

nearby wells or in municipal water supplies is addressed. The designed shielding distances and beam dumps are such that the induced radioactivity in ground water is safely smaller than the levels permitted by EPA and international agencies.

30416 (SSC-SR–1031) **Workshop on radiological aspects of SSC operations.** Toohig, T.E. (ed.). Lawrence Berkeley Lab., CA (United States). SSC Central Design Group. May 1987. 56p. Sponsored by USDOE, Washington, DC (United States). DOE Contract AC35-89ER40486. (CONF-8705425–: Workshop in radiological aspects of Superconducting Super Collider (SSC) Operations, Berkeley, CA (United States), 4-6 May 1987). Order Number DE95011092. Source: OSTI; NTIS; GPO Dep.

Integral to the design of an accelerator facility is the provision of adequate shielding to contain any radiation arising from operation of the facility. Complementary to the questions of environmental shielding are a number of radiation questions related to operation of the completed facility. One obvious need is the specification of systems for monitoring environmental emissions to ensure consistency between the design criteria and the actual levels during operation. Another question is the effect on the components of the machine of the radiation within the environmental shield. These questions were examined at the workshop. This report is a summary of the materials presented at the workshop.

30417 (UCRL-ID–120596) **Photoproduction of tritium.** Becker, J.A.; Anderson, J.D.; Weiss, M.S. Lawrence Livermore National Lab., CA (United States). 23 Mar 1995. 5p. Sponsored by USDOE, Washington, DC (United States). DOE Contract W-7405-ENG-48. Order Number DE96001007. Source: OSTI; NTIS; INIS; GPO Dep.

^{3}H (Tritium) is required for maintenance of nuclear weapons in the stockpile. The National Defense need for ^{3}H was historically met by the Savannah River Facility. This facility is no longer safe for operation. ^{3}H decays with a mean lifetime τ = 17.8 y, and therefore new methods of ^{3}H production are required to meet US military requirements. Irradiation of ^{7}Li by low-energy photons produces tritium (^{3}H) via the photodisintegration process. Waste heat from the ^{7}Li target can be extracted and used for the direct generation of electricity. Other advantages include: negligible residual radioactivity, simple target technology, small low-energy electron accelerators for bremsstrahlung production (the photon source), developed liquid metal technology, modularity, simple extraction of ^{3}H from a recirculating ^{7}Li target, abundant supply of ^{7}Li, and straightforward target-accelerator-bremsstrahlung converter interface. A schematic plant characterized by very low risk is described, and a figure-of-merit is obtained.

30418 (UCRL-ID–121571, pp. Paper 1, 10 Pages) **The RHIC status update.** Ozaki, S. (Brookhaven National Lab., Upton, NY (United States)). Lawrence Berkeley Lab., CA (United States). 15 Jul 1995. (CONF-950198–: Physics with the collider detectors at Relavitistic Heavy Ion Collider (RHIC) and the LHC, Livermore, CA (United States), 8 Jan 1995). In *Physics with the collider detectors at RHIC and the LHC*. 212p. Order Number DE95015976. Source: OSTI; NTIS; INIS; GPO Dep.

The construction of the Relativistic Heavy Ion Collider (RHIC) began in 1991, with the completion date originally scheduled for 1997. Significant reduction of the funding levels in FY 1993 and 1994, and the funding level cap for FY 1995 and later years caused a 19-month stretchout of the construction period to the second quarter of FY 1999, and an increase of the total estimated cost (TEC) to $475 M. The Project, therefore, is now at the halfway mark of the construction period with actual cost and schedule performance tracking close to the DOE-approved baseline. Construction funding through FY 1994 reached close to 60% of the TEC. Incidentally, if one adds the current value of preexisting facilities which will be incorporated into RHIC, such as the injection system (Tandem Van de Graaff - the Booster - the AGS), the esixting 3.8 km tunnel, the 24 kW helium refrigerator, etc., the total value of the RHIC facility, when completed, will reach one billion dollars, if not more. The accelerator lattice design was finalized in 1992 after an intensive study was made to optimize the collider design for performance, operational flexibility, and value engineering. The civil construciton, including the collider enclosure, magnet access ports to the ring tunnel, and six service buildings for accelerator power supplies and cryogenic control boxes was completed.

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Refer also to citation(s) 30359, 30360, 30384, 30397, 30409, 30499, 31227, 31229, 31276

30419 (BNL–52481) **Numerical spin tracking in a synchrotron computer code Spink: Examples (RHIC).** Luccio, A. Brookhaven National Lab., Upton, NY (United States). 14 Sep 1995. 22p. Sponsored by USDOE, Washington, DC (United States). DOE Contract AC02-76CH00016. (AGS/AD–95-2). Order Number DE96000688. Source: OSTI; NTIS; INIS; GPO Dep.

In the course of acceleration of polarized protons in a synchrotron, many depolarizing resonances are encountered. They are classified in two categories: Intrinsic resonances that depend on the lattice structure of the ring and arise from the coupling of betatron oscillations with horizontal magnetic fields, and imperfection resonances caused by orbit distortions due to field errors. In general, the spectrum of resonances vs spin tune $G\gamma$(G = 1.7928, the proton gyromagnetic anomaly, and γ the proton relativistic energy ratio) for a given lattice tune ν, or vs ν for a given $G\gamma$, contains a multitude of lines with various amplitudes or resonance strengths. The depolarization due to the resonance lines can be studied by numerically tracking protons with spin in a model accelerator. Tracking will allow one to check the strength of resonances, to study the effects of devices like Siberian Snakes, to find safe lattice tune regions where to operate, and finally to study in detail the operation of special devices such as Spin Flippers. A few computer codes exist that calculate resonance strengths E_k and perform tracking, for proton and electron machines. Most relevant to our work for the AGS and RHIC machines are the programs Depol and Snake. Depol, calculates the E_k's by Fourier analysis. The input to Depol is the output of a machine model code, such as Synch or Mad, containing all details of the lattice. Snake, does the tracking, starting from a synthetic machine, that contains a certain number of periods, of FODO cells, of Siberian snakes, etc. We believed the complexities of machines like the AGS or RHIC could not be adequately represented by Snake. Then, we decided to write a new code, Spink, that combines some of the features of Depol and Snake. I.E., Spink reads a Mad output like Depol and tracks as Snake does. The structure of the code and examples for RHIC are described in the following.

30420 (FNAL/C–95/268) **Nonlinear mode coupling analysis in the Tevatron.** Assadi, S.; Mishra, C.S. Fermi National Accelerator Lab., Batavia, IL (United States). Aug 1995. 10p. Sponsored by USDOE, Washington, DC (United States). DOE Contract AC02-76CH03000. (CONF-950512–327: Particle accelerator conference, Dallas, TX (United States), 1-5 May 1995). Order Number DE96000106. Source: OSTI; NTIS; INIS; GPO Dep.

Increased demand for higher luminosities from Fermilab proton-antiproton collider requires higher intensities and increased number of bunches. The performance of existing 6 x 6 and the proposed 36 x 36 collider is often limited by the non-linear effects arising from beam-beam interactions, in particular for high intensity beams. The tune shifts and spread from increased long range interactions combined with higher order multipoles complicates the frequency spectrum of the particle motions. TEAPOT simulation program is used to generate turn by turn data that could be used in the nonlinear mode spectrums analysis. Bispectral mode analysis is discussed.

30421 (FNAL/C–95/269) **Simulation of beam-beam effects in tevatron.** Mishra, C.S. (Fermi National Accelerator Lab., Batavia, IL (United States)); Assadi, S.; Talman, R. Fermi National Accelerator Lab., Batavia, IL (United States). Aug 1995. 10p. Sponsored by USDOE, Washington, DC (United States). DOE Contract AC02-76CH03000. (CONF-950512–335: Particle accelerator conference, Dallas, TX (United States), 1-5 May 1995). Order Number DE96000109. Source: OSTI; NTIS; INIS; GPO Dep.

The Fermilab accelerator complex is in the middle of an upgrade plan Fermilab III. In the last phase of this upgrade the luminosity of

the Tevatron will increase by at least one order of magnitude. In order to keep the number of interactions per crossing manageable for experiments, the number of bunches will be increased from 6 x 6 to 36 x 36 and finally to ~100 x 100 bunches. The beam dynamics of the Tevatron has been studied from Beam-Beam effect point of view in a "Strong-Weak" representation with a single particle being tracked in presence of other beam. This paper describes the beam-beam effect in 6 x 6 operation of Tevatron.

30422 (FNAL-TM–1947) **A study into lowering beam trajectories in P01.** Sondgeroth, A. Fermi National Accelerator Lab., Batavia, IL (United States). Sep 1995. 8p. Sponsored by USDOE, Washington, DC (United States). DOE Contract AC02-76CH03000. Order Number DE96000442. Source: OSTI; NTIS; INIS; GPO Dep.

This document describes what changes would be needed to lower the primary beams coming from switchyard into enclosure P01 without changing trajectories in the downstream enclosures. There is a 680 foot pipe buried in the ground between Enclosure E and P01 which allows primary beam to travel from the switchyard area to the research division area. This pipe is approximately 25 years old and has started to leak. The effects of the leaky pipe can be catastrophic to the transportation of the proton area beams. The vacuum group has devised an ingenious way of repairing a leak from the inside using remotely controlled grinders, patchers, welders and cameras mounted on carts that can be pulled into the pipe. A typical patch adds approximately one half of an inch of material which, in turn, restricts the aperture of the pipe. This pipe has three separate beams running through it split in the vertical plane. Pwest is the highest beam in the pipe and, in at least one location, the center of the beam clears the top of the pipe by one and one half inches. If a leak were to develop at a low spot in the pipe the patch to fix the leak might create an obstruction for the beam. Hence, the request from the Research Division Head.

30423 (IFVE-ORI–94-112) **Building program environment for geometrical module of MARS program complex.** Talanov, V.V. Gosudarstvennyj Komitet po Ispol'zovaniyu Atomnoj Ehnergii SSSR, Serpukhov (Russian Federation). Inst. Fiziki Vysokikh Ehnergij. 1994. 8p. (In Russian). Order Number DE96601951. Source: OSTI; NTIS (US Sales Only); INIS.

Program environment developed for geometrical module of IHEP MARS program complex is presented. The procedures of program environment are designed for the use of data bases, conversion of geometry descriptions and output of geometrical information. 12 refs.; 3 figs.

30424 (LA-UR–95-17922, pp. 363-369) **Beam physics design strategy for a high-current rf linac.** Reiser, M. (Univ. of Maryland, College Park, MD (United States)). Los Alamos National Lab., NM (United States). [1995]. (CONF-9407103–: International conference on accelerator-driven transmutation technologies and applications, Las Vegas, NV (United States), 25 Jul - 1 aug 1994). In *AIP conference on accelerator driven transmutation technologies and applications, Los Vegas, Nevada, July 25-29, 1994.* 958p. Order Number DE95014018. Source: OSTI; NTIS; INIS.

The high average beam power of an rf linac system for transmutation of nuclear waste puts very stringent requirements on beam quality and beam control. Fractional beam losses along the accelerator must be kept at extremely low levels to assure "hands-on" maintenance. Hence, halo formation and large-amplitude tails in the particle distribution due to beam mismatch and equipartitioning effects must be avoided. This implies that the beam should ideally be in near-perfect thermal equilibrium from injection to full energy - in contrast to existing rf linacs in which the transverse temperature, $T_{\perp}$, is higher than the longitudinal temperature, $T_{\parallel}$. The physics and parameter scaling for such a system will be reviewed using the results of recent work on high-intensity bunched beams. A design strategy for a high-current rf linac with equilibrated beam will be proposed.

30425 (LA-UR–95-17922, pp. 376-381) **Emittance growth and halo formation in charge-dominated beams.** Bondarev, B.I. (Moscow Radiotechnical Institute (Russian Federation)); Durkin, A.P.; Murin, B.P. Los Alamos National Lab., NM (United States). [1995]. (CONF-9407103–: International conference on accelerator-driven transmutation technologies and applications, Las Vegas, NV (United States), 25 Jul - 1 aug 1994). In *AIP conference on accelerator driven transmutation technologies and applications, Los Vegas, Nevada, July 25-29, 1994.* 958p. Order Number DE95014018. Source: OSTI; NTIS; INIS.

The optimization of high-current high-energy linacs against the low beam loss requirement is not straightforward or well-codified. Outlying particle losses at the 10^{-5} up to 10^{-8} level might have only a small effect on the rms properties of the beam, and thus the total beam size must be constantly kept under observation. RMS-physics has gained wide-spread acceptance as a necessary design tool, but its sufficiency is an issue for ATW/ABC accelerators.

30426 (LBL–36435) **Reduction of nonlinear resonance excitation from insertion devices in the ALS.** Robin, D. (Lawrence Berkeley Lab., CA (United States)); Krebs, G.; Portmann, G.; Zholents, A.; Decking, W. Lawrence Berkeley Lab., CA (United States). Apr 1995. 3p. Sponsored by USDOE, Washington, DC (United States). DOE Contract AC03-76SF00098. (CONF-950512–341: Particle accelerator conference, Dallas, TX (United States), 1-5 May 1995). Order Number DE96001308. Source: OSTI; NTIS; INIS; GPO Dep.

Theoretical studies of Lawrence Berkeley Laboratory's Advanced Light Source (ALS) storage ring predict strong field insertion devices will break the rings symmetry, increasing resonance excitation that may reduce the dynamic aperture and thus the beam lifetime. The authors have embarked on an experimental program to study the strength of nonlinear resonance excitation in the ALS when insertion devices are present. They observe an enhancement in the resonance excitation of a third-order resonance when the gap of the insertion device is narrowed. They also find that it is possible to suppress this resonance by detuning two quadruples on either side of the insertion device. The results of this study are presented in this paper.

30427 (LBL–36440) **Beam lifetime and beam brightness in ALS.** Kim, C.; Jackson, A.; Warwick, A. Lawrence Berkeley Lab., CA (United States). Apr 1995. 3p. Sponsored by USDOE, Washington, DC (United States). DOE Contract AC03-76SF00098. (CONF-950512–320: Particle accelerator conference, Dallas, TX (United States), 1-5 May 1995; LSGN–195). Order Number DE96000143. Source: OSTI; NTIS; GPO Dep.

Beam lifetime in ALS is dominated by the Touschek scattering. Measurements of lifetime in single-bunch mode with estimates of bunch dimensions obtained from undulator radiation data are consistent with expectations (t=1.8 hours at 1.25 mA per bunch). However, the lifetime is significantly longer in multi-bunch mode (t=ll hours at 400 mA per 320 bunches). This discrepancy has been traced to an increase in the momentum spread and bunch length in the beam caused by longitudinal coupled-bunch motions driven by higher-order modes in the rf cavities. The increased momentum spread leads to a significant degradation in the undulator spectral performance. Feedback stabilization of the coupled-bunch motion improves the spectral characteristics of the undulator beam at the expense of beam lifetime. We observe an increase of ~200% in beam lifetime by operating at the betatron coupling resonance.

30428 (LBL–36443) **Orbit control at the ALS based on sensitivity matrices.** Nishimura, H.; Schachinger, L.; Ohgaki, H. Lawrence Berkeley Lab., CA (United States). Apr 1995. 3p. Sponsored by USDOE, Washington, DC (United States). DOE Contract AC03-76SF00098. (CONF-950512–340: Particle accelerator conference, Dallas, TX (United States), 1-5 May 1995). Order Number DE96001309. Source: OSTI; NTIS; INIS; GPO Dep.

A third-generation synchrotron-light source storage ring requires accurate orbit correction because its lattice is very sensitive to magnet imperfections and misalignments. If model-based control is used, calibration of this model is required in advance. Therefore, it is preferable to prepare some kind of model-free orbit control scheme that is complementary to model-based control. A sensitivity matrix (S matrix) works effectively as the kernel of a model-free orbit control system for a given optics of a lattice. This paper describes recent efforts in this respect at Advanced Light Source (ALS).

30429 (LBL–36458) **The beam envelope equation – Systematic solution for a FODO lattice with space charge.** Lee,

E.P. (Lawrence Berkeley Lab., CA (United States). Accelerator and Fusion Research Div.). Lawrence Berkeley Lab., CA (United States). May 1995. 3p. Sponsored by USDOE, Washington, DC (United States). DOE Contract AC03-76SF00098. (CONF-950512–323: Particle accelerator conference, Dallas, TX (United States), 1-5 May 1995). Order Number DE96000132. Source: OSTI; NTIS; INIS; GPO Dep.

Many approximate solutions for matched beam envelope functions with space charge have been developed; they generally have efforts of 2–10% for the parameters of interest and cannot be reliably improved. The new, systematic approach described here provides the K-V envelope functions to arbitrarily high accuracy as a power series in the quadrupole gradient. A useful simplification results from defining the sum and difference of the envelope radii; S = (a+b)/2 varies only slightly with distance z along the system axis, and D = (a-b)/2 contains most of the envelope oscillations. To solve the coupled equations for S and D, the quadrupole strength K(z) is turned on by replacing K with αK_1 and letting α increase continuously from 0 to 1. It is found that S and D may be expanded in even and odd powers of α, respectively. Equations for the coefficients of powers of α are then solved successively by integration in z. The periodicity conditions and tune integration close the calculation. Simple low order results are typically accurate to 1% or better.

30430 (LBL–36576) **Design of end magnetic structures for the Advanced Light Source wigglers.** Humphries, D.; Akre, J.; Hoyer, E.; Marks, S.; Minamihara, Y.; Pipersky, P.; Plate, D.; Schlueter, R. Lawrence Berkeley Lab., CA (United States). Apr 1995. 3p. Sponsored by USDOE, Washington, DC (United States). DOE Contract AC03-76SF00098. (LSGN–213; CONF-950512–319: Particle accelerator conference, Dallas, TX (United States), 1-5 May 1995). Order Number DE96000142. Source: OSTI; NTIS; GPO Dep.

The vertical magnetic structures for the Advanced Light planar wiggler and 20 cm period elliptical hybrid permanent magnet design. The ends of these structures are characterized by diminishing scalar potential distributions the poles which control beam trajectories. They incorporate electromagnetic correction coils to dynamically correct for variations in the first integral of the field as a function of gap. A permanent magnet trim mechanism is incorporated to minimize the transverse integrated error field distribution. The ends were designed using analytic and computer modeling techniques. The design and modeling results are presented.

30431 (LBL–37340) **Three dimensional pure permanent magnet undulator design theory.** Schlueter, R.D.; Marks, S. Lawrence Berkeley Lab., CA (United States). Jun 1995. 4p. Sponsored by USDOE, Washington, DC (United States). DOE Contract AC03-76SF00098. (LSGN–216; CONF-950691–17: 14. international conference on magnet technology, Tampere (Finland), 11-16 Jun 1995). Order Number DE96000146. Source: OSTI; NTIS; GPO Dep.

Expressions for fields due to a point charge in 3D and due to a line charge in 2D are compared. Extensions to dipoles are made with emphasis on the relationship between dipole orientation and field component magnitudes. Differences between the effects on fields of dipole rotations in 2D and in 3D are highlighted and formulas for maximizing individual field components are given. A final macrogeometry extension is made and a closed-form expression is developed to calculate the field due to an arbitrary 3D configuration of permanent magnet (PM) blocks. The field optimization theory is applied to the design of the ALS elliptically polarizing undulator (EPU). Utilizing 3D field enhancement, peak on-axis field in practical designs can be increased typically by 5% to 40% or more over their 2D counterparts. The theory is generally applicable to any pure (i.e., no soft magnetic material) PM design.

30432 (LS–114) **Impedance studies. Part 3, Transverse-loss compensation.** Chou, W.; Jin, Y. Argonne National Lab., IL (United States). [1988]. 5p. Sponsored by USDOE, Washington, DC (United States). DOE Contract W-31-109-ENG-38. Order Number DE95015556. Source: OSTI; NTIS; GPO Dep.

Short communication. ADVANCED PHOTON SOURCE/ impedance; IMPEDANCE; ENERGY LOSSES; RF SYSTEMS

30433 (LS–157) **3-D computer simulations of EM fields in the APS vacuum chamber: Part 1, Frequency-domain analysis.** Chou, W.; Bridges, J. Argonne National Lab., IL (United States). 4 Sep 1990. 13p. Sponsored by USDOE, Washington, DC (United States). DOE Contract W-31-109-ENG-38. Order Number DE95015553. Source: OSTI; NTIS; GPO Dep.

The vacuum chamber proposed for the storage ring of the 7-GeV Advanced Photon Source (APS) basically consists of two parts: the beam chamber and the antechamber, connected to each other by a narrow gap. A sector of 1-meter-long chamber with dosed end plates, to which are attached the 1-inch-diameter beampipes centered at the beam chamber, has been built for experimental purposes. The 3-D code MAFIA has been used to simulate the frequency-domain behaviors of EM fields in this setup. The results are summarized in this note and are compared with that previously obtained from 2-D simulations and that from network analyzer measurements. They are in general agreement. A parallel analysis in the time-domain is reported in a separate note. The method of our simulations can be briefly described as follows. The 1-inch diameter beampipes are terminated by conducting walls at a length of 2 cm. The whole geometry can thus be considered as a cavity. The lowest RF modes of this geometry are computed using MAFIA. The eigenfrequencies of these modes are a direct output of the eigenvalue solver E3, whereas the type of each mode is determined by employing the postprocessor P3. The mesh sizes are chosen such that they are small enough for computations in the frequency region in which we are interested (the sampling theorem), while the total number of mesh points is still well within the range that our computer system can cope with.

30434 (LS–179) **The effect of small ellipsoidal material on the resonant frequency of a cavity.** Khoe, T. Argonne National Lab., IL (United States). [1995]. 10p. Sponsored by USDOE, Washington, DC (United States). DOE Contract W-31-109-ENG-38. Order Number DE95015498. Source: OSTI; NTIS; GPO Dep.

This report calculates the electromagnetic fields in a resonant cavity when a small ellipsoidal material is present.

30435 (SLAC-PUB–95-6847) **Ion effects in future circular and linear accelerators.** Raubenheimer, T.O. Monsanto Research Corp., Miamisburg, OH (United States). Mound. May 1995. 5p. Sponsored by USDOE, Washington, DC (United States). DOE Contract AC03-76SF00515. (CONF-950512–313: Particle accelerator conference, Dallas, TX (United States), 1-5 May 1995). Order Number DE95017723. Source: OSTI; NTIS; INIS; GPO Dep.

In this paper, the author discusses ion effects relevant to future storage rings and linear colliders. The author first reviews the conventional ion effects observed in present storage rings and then discusses how these effects will differ in the next generation of rings and linacs. These future accelerators operate in a new regime because of the high current long bunch trains and the very small transverse beam emittances. Usually, storage rings are designed with ion clearing gaps to prevent ion trapping between bunch trains or beam revolutions. Regardless, ions generated within a single bunch train can have significant effects. The same is true in transport lines and linacs, where typical vacuum pressures are relatively high. Amongst other effects, the author addresses the tune spreads due to the ions and the resulting filamentation which can severely limit emittance correction techniques in future linear colliders, the bunch-to-bunch coupling due to the ions which can cause a multi-bunch instability with fast growth rates, and the betatron coupling and beam halo creation which limit the vertical emittance and beam lifetimes.

30436 (SLAC-PUB–95-6856) **RF feedback simulation results for PEP-II.** Tighe, R.; Corredoura, P. Stanford Univ., CA (United States). Jun 1995. 4p. Sponsored by USDOE, Washington, DC (United States). DOE Contract AC03-76SF00515. (CONF-950512–314: Particle accelerator conference, Dallas, TX (United States), 1-5 May 1995). Order Number DE95017724. Source: OSTI; NTIS; INIS; GPO Dep.

A model of the RF feedback system for PEP-II has been developed to provide time-domain simulation and frequency-domain analysis of the complete system. The model includes the longitudinal beam dynamics, cavity fundamental resonance, feedback

loops, and the nonlinear klystron operating near saturation. Transients from an ion clearing gap and a reference phase modulation from the longitudinal feedback system are also studied. Growth rates are predicted and overall system stability examined.

30437 (SLAC-PUB–95-6936) **Summary of Working Group I - beam-beam instability with crossing angle.** Chen, T. Stanford Univ., CA (United States). Jun 1995. 5p. Sponsored by USDOE, Washington, DC (United States). DOE Contract AC03-76SF00515. (CONF-9505171–2: Comprehensive photovoltaic system design seminar, Camarillo, CA (United States), 15-19 May 1995). Order Number DE95017726. Source: OSTI; NTIS; INIS; GPO Dep.

This report is a summary report from a panel addressing the problem of beam-beam instability in colliding beams at finite crossing angles. This problem arises in the process of increasing luminosity in large circular particle factories. The primary means of increasing luminosity comes down to increasing the number of bunches in each beam, while decreasing the spacing between bunches. This situation favors finite crossing angle collision schemes. However such schemes allow synchro-betatron coupling, as transverse and longitudinal energies are mixed. The authors summarize their discussions on this problem, and the present state of experience with such schemes.

30438 (SLAC-R–95-472) **Transverse wakefield of waveguide damped structures and beam dynamics.** Lin, X. Stanford Univ., CA (United States). Aug 1995. 148p. Sponsored by USDOE, Washington, DC (United States). DOE Contract AC03-76SF00515. Order Number DE96000816. Source: OSTI; NTIS; INIS; GPO Dep.

In the design of new high energy particle colliders with higher luminosity one is naturally led to consider multi-bunch operation. However, the passage of a leading bunch through an accelerator cavity Generates a wakefield that may have a deleterious effect on the motion of the subsequent bunches. Therefore, the suppression of the wakefield is an essential requirement for beam stability. One solution to this problem, which has been studied extensively is to drain the wakefield energy out of the cavity by means of waveguides coupled with the cavity and fed into matched terminations. Waveguide dimensions are chosen to yield a cutoff frequency well above the frequency of the accelerating mode so that the latter is undamped. This paper presents a thorough investigation of the wakefield for this configuration. The effectiveness of waveguide damping has typically been assessed by evaluating the resultant Q_{ext} of higher order cavity modes to determine their exponential damping rate. We have developed an efficient method to calculate Q_{ext} of the damped modes from popular computer simulation codes such as MAFIA. This method has been successively applied to the B-factory RF cavity We have also found another type of wakefield, associated with waveguide cut-off, which decays as $t^{-3/2}$ rather than in the well-known exponentially damped manner. Accordingly, we called it the persistent Wakefield. A similar phenomenon with essentially the same physical origin but occurring in the decay of unstable quantum states, has received extensive study. Then we have developed various methods of calculating this persistent wakefield, including mode matching and computer simulation. Based on a circuit model we estimate the limit that waveguide damping can reach to reduce the wakefield.

30439 (SSCL–282) **The vortices in the latticed model of the planar nematic.** Khvechshenko, D.V.; Kogan, Y.I.; Nechaev, S.K. Superconducting Super Collider Lab., Dallas, TX (United States). Jun 1990. 14p. Sponsored by USDOE, Washington, DC (United States). DOE Contract AC35-89ER40486. Order Number DE95011226. Source: OSTI; NTIS; INIS; GPO Dep.

The vortices in the planar nematic are considered using the field-theoretical description in terms of the Rp^2 σ-model. In the strong-coupling expansion the vortices interactions are considered and the new type of phase transition is obtained in the mean-field approximation.

30440 (SSCL-Preprint–223) **Emittance growth and halo formation in a low energy proton beam.** Palkovic, J. Superconducting Super Collider Lab., Dallas, TX (United States). Apr 1993. 18p. Sponsored by USDOE, Washington, DC (United States). DOE Contract AC35-89ER40486. Order Number DE95011195. Source: OSTI; NTIS; INIS; GPO Dep.

We have measured emittances in a low-energy proton beam at energies between 19 and 45 KeV and currents between 9 and 39 mA. The rms emittance of the space-charge dominated proton beam, as measured by a moving-slit emittance probe, grew by an average amount of 60% in a propagation distance of 2.5 cm. An Abel inversion procedure was applied to the measured transverse charge distribution of the proton beam in order to calculate the electrostatic field energy, which is the driving quantity for emittance growth. We have found that all of the emittance growth is due to a halo containing $\simeq$ 10% of the beam particles.

30441 (SSCL-Preprint–510) **Theoretical study of longitudinal beam splitting and related phenomena.** Ellison, J. (Superconducting Super Collider Lab., Dallas, TX (United States)); Shih, H.J.; Kummer, M. Superconducting Super Collider Lab., Dallas, TX (United States). Oct 1993. 15p. Sponsored by USDOE, Washington, DC (United States). DOE Contract AC35-89ER40486. Order Number DE95011220. Source: OSTI; NTIS; INIS; GPO Dep.

A recent experiment at the Indiana University Cyclotron Facility (IUCF) with electron cooling showed that rf phase modulation near 1:1 resonance leads to longitudinal beam splitting. Here we explain this by applying the method of averaging, a powerful tool from the study of dynamical systems, to the underlying equation of motion – a pendulum equation with small damping and periodic forcing. The beam splitting is explained by showing that the associated Poincare map has two attracting fixed points, each with a well-defined basin of attraction. Our approach can be immediately applied to other accelerator physics problems governed by a similar equation.

4303 Auxiliaries and Components

Refer also to citation(s) 28869, 28870, 28879, 28883, 29541, 30118, 30397, 30406, 30422, 30429, 30430, 30431, 30433, 30438, 30491, 30496, 30500, 30509, 30523, 30524, 30604, 30622, 30624, 30804, 31149, 31228, 31235, 31250

30442 (BNL–61797) **Development of an EBIS for a RHIC preinjector.** Beebe, E. (Brookhaven National Lab., Upton, NY (United States)); Alessi, J.; Hershcovitch, A.; Kponou, A.; Prelec, K.; Schmieder, R.W. Brookhaven National Lab., Upton, NY (United States). [1995]. 15p. Sponsored by USDOE, Washington, DC (United States). DOE Contract AC02-76CH00016. (CONF-9509125–3: 6. international conference on ion sources, Whistler (Canada), 10-16 Sep 1995; KA–02-01). Order Number DE96000433. Source: OSTI; NTIS; INIS; GPO Dep.

At Brookhaven, an Electron Beam Ion Source (EBIS) is operational as a test bed for development of a high current EBIS for RIEC. Previously, the goal of most EBIS research has been to produce bare or nearly bare nuclei. At BNL, the EBIS is required to produce only medium charge states of heavy ions e.g., Au^{35+}, since there is further stripping at higher energies. The BNL effort is directed at reaching intensities of interest to FJMC, approximately 3×10^9 particles/pulse, which will require an EBIS electron beam on the order of 10A. Initial tests using a 1 mm LaB_6 cathode have produced electron beam currents up to the design value of 110mA. A 2mm LaB_6 cathode has been installed and in a first run has produced currents up to 350mA. This source has so far produced charge states up to Ar^{16+} using neutral gas injection, and up to Tl^{50+} using external ion injection. Results of these studies and ion injection trials are presented.

30443 (BNL–62222) **Optimization of parameters for the inline-injection system at Brookhaven Accelerator Test Facility.** Parsa, Z. (Brookhaven National Lab., Upton, NY (United States)); Ko, S.K. Brookhaven National Lab., Upton, NY (United States). [1995]. 250p. Sponsored by USDOE, Washington, DC (United States). DOE Contract AC02-76CH00016. Order Number DE96001158. Source: OSTI; NTIS; INIS; GPO Dep.

We present some of our parameter optimization results utilizing code PARMLEA, for the ATF Inline-Injection System. The new solenoid-Gun-Solenoid – Drift-Linac Scheme would improve the beam quality needed for FEL and other experiments at ATF as compared to the beam quality of the original design injection system. To optimize the gain in the beam quality we have considered various parameters including the accelerating field gradient on the

photoathode, the Solenoid field strengths, separation between the gun and entrance to the linac as well as the (type size) initial charge distributions. The effect of the changes in the parameters on the beam emittance is also given.

30444 (CONF-950512–305) **Performance enhancement of a compact radio frequency ion source by the injection of supplemental electrons.** Welton, R.F.; Alton, G.D.; Becher, D.; Mills, G.D.; Dellwo, J.; Murray, S.N. Oak Ridge National Lab., TN (United States). [1995]. 8p. Sponsored by USDOE, Washington, DC (United States). DOE Contract AC05-84OR21400. From Particle accelerator conference; Dallas, TX (United States); 1-5 May 1995. Order Number DE95013976. Source: OSTI; NTIS; INIS; GPO Dep.

A versatile, high brightness, volume type, low power RF source, capable of producing positive ion beams with intensities as high as 1 mA from gaseous feed materials and microamperes of negative ion beams has been characterized. The source can also be operated as a plasma sputter negative ion source to generate up to 1 mA of a selected species. The performance of the source in the positive and negative volume modes of operation can be greatly enhanced by addition of a removable, water cooled filament assembly in place of the negative sputter probe. For examine, the material utilization efficiencies of gaseous feed species can be more than doubled, total current intensities increased up to 40%, molecular dissociation fractions increased by 20% and minimum operating pressures reduced by a factor of four when operated in the volume mode. These added electrons also favorably effect, as a consequence of lower pressures, the emittance apparently through a reduction of scattering in the beam through the transport system. A brief description of the source and performance data for the positive volume mode of operation is presented.

30445 (DOE/ER/40537–51) **A beat frequency buncher.** Storm, D.W.; Corcoran, D.T.; Harper, G.C. Washington Univ., Seattle, WA (United States). Nuclear Physics Lab. [1995]. 8p. Sponsored by USDOE, Washington, DC (United States). DOE Contract FG06-90ER40537. (CONF-9509230–1: 7. international conference on heavy ion accelerator technology, Canberra (Australia), 18-22 Sep 1995). Order Number DE95017519. Source: OSTI; NTIS; INIS; GPO Dep.

A superconducting high energy buncher operating at 13/12 times the linac frequency has been built and installed, to combine with the low energy buncher operating at 1/12 the linac frequency. The system is synchronized so the linac and high energy buncher beat frequency remains in phase with the low energy buncher. On linac cycles not corresponding to a primary bunch, the high energy buncher bunches residual beam away from the linac longitudinal acceptance rather than into it. The resonator for the new high energy buncher was constructed by shortening an existing low-β resonator.

30446 (FNAL-TM–1933) **A prototype lattice design for a 2 TeV $\mu^+ - \mu^-$ collider.** Gelfand, N.M. Fermi National Accelerator Lab., Batavia, IL (United States). Aug 1995. 13p. Sponsored by USDOE, Washington, DC (United States). DOE Contract AC02-76CH03000. Order Number DE95017627. Source: OSTI; NTIS; INIS; GPO Dep.

This is a description of a prototype lattice for a μ-μ collider. It is not intended to be a final design, that is the design for a collider lattice which will be built. This prototype design will need to be optimized as the constraints and the requirements for the collider are better understood. As this is done the present design will be replaced by a superior design. Nonetheless this prototype can be used as a benchmark and a means of identifying problems. This is a geometric design, that is the beam energy does not enter into the properties of the elements of the design. Since the proposed energy for the μ-μ collider is 2TeV x 2TeV this energy has been used to compute the gradients needed in the quadrupoles. At an energy of 2TeV, and with superconducting dipoles of ~8T the circumference of the ring is ~6km. Since the luminosity depends exponentially on the length of the lattice an important design criterion will be to minimize the length of the ring. This will be done with careful design of the interaction regions (IR), the utility straight sections, and even the standard cells in the arcs.

30447 (IFVE-OKU–94-93) **On a possibility of use of bent crystals for extraction a beam from accelerator.** Aseev, A.A.; Gorin, M.Yu.; Kalajdov, A.V. Gosudarstvennyj Komitet po Ispol'zovaniyu Atomnoj Ehnergii SSSR, Serpukhov (Russian Federation). Inst. Fiziki Vysokikh Ehnergij. 1994. 12p. (In Russian). Order Number DE96601958. Source: OSTI; NTIS (US Sales Only); INIS.

Installation of a Si bent crystal before the first septum-magnet in the existing slow extraction scheme of the IHEP accelerator allowed to extract for experiments in nonresonant slow extraction mode a part of protons lost on the limit of septum-magnet apertures. Experiments show that in this mode by $3x10^8$ protons can be extracted additionally. This is about 10 to 30% of a beam intensity extracted towards channel 22 without a bent crystal. The use of an unbent crystal as an amorphous target leads to decrease of an extracted beam intensity. 13 refs.; 6 figs.

30448 (IFVE-OKU–94-100) **Characteristics of betatron resonances at the booster IHEP.** Pashkov, P.T.; Smirnov, A.V. Gosudarstvennyj Komitet po Ispol'zovaniyu Atomnoj Ehnergii SSSR, Serpukhov (Russian Federation). Inst. Fiziki Vysokikh Ehnergij. 1994. 8p. (In Russian). Order Number DE96601960. Source: OSTI; NTIS (US Sales Only); INIS.

Based on the magnetic measurement data, characteristics of betatron resonances near the booster's operational tune point are calculated. Tolerable detuning of betatron frequencies w.r.t. their resonance values are estimated. The extent of danger inflicted by the individual betatron resonances is discussed. 4 refs.; 1 fig.; 2 tabs.

30449 (IFVE-OLU–94-105) **Numerical methods for matching the beam phase space distribution from ion gun to linac using axially symmetric electrostatic lenses.** Frolov, B.A. Gosudarstvennyj Komitet po Ispol'zovaniyu Atomnoj Ehnergii SSSR, Serpukhov (Russian Federation). Inst. Fiziki Vysokikh Ehnergij. 1994. 31p. (In Russian). Order Number DE96601962. Source: OSTI; NTIS (US Sales Only); INIS.

The methods and results of the numerical calculation of the matching channel constructed from electrostatic axially-symmetric lenses are described. The beam with a required configuration in the transverse phase space at the entrance of Linac (which is determined with effective ellipse semiaxis values and orientation) is formed by optimizing geometrical and potential parameters of the electron-optic system. 17 refs.; 6 figs.; 1 tab.

30450 (IFVE-OP–94-28) **The double purpose muon-neutrino beam with the free decay path.** Kartashev, V.P.; Novoskol'tsev, F.N. Gosudarstvennyj Komitet po Ispol'zovaniyu Atomnoj Ehnergii SSSR, Serpukhov (Russian Federation). Inst. Fiziki Vysokikh Ehnergij. 1994. 12p. (In Russian). Order Number DE96601963. Source: OSTI; NTIS (US Sales Only); INIS.

The double purpose muon-neutrino beam-line with the free decay path to simultaneously obtain good quality muon and dichromatic neutrino beams is described. The two object-lens quadrupole focusing system forms the parent particles beam. The requirements to the focusing system for obtaining of π, K-beam with an acceptable spot sizes all along the free decay path are given. To reduce the muon halo of unwanted muons in a 4x4 m^2 area at the experiment a toroidal magnetized iron is used. A detailed analysis of the beam for 500 GeV initial proton beam has been carried out. 9 refs.; 5 figs.; 4 tabs.

30451 (LA-SUB–95-102) **Computational support for ITS and PHERMEX. Final report.** Hughes, T.P. (Mission Research Corp., Albuquerque, NM (United States)); Clark, R.E.; Allison, P.W.; Moir, D.C.; Kauppila, T.J.; Watson, S.A. Los Alamos National Lab., NM (United States); Mission Research Corp., Albuquerque, NM (United States). Mar 1994. 62p. Sponsored by USDOE, Washington, DC (United States). DOE Contract W-7405-ENG-36. (MRC/ABQ-R–1686). Order Number DE95016318. Source: OSTI; NTIS; GPO Dep.

This report describes calculations carried out over the past year in support of the ITS and PHERMEX radiographic machines. The forces produced by nonaxisymmetric structures in the ITS linac were calculated using 3-D simulations. The quadrupole magnetic field produced by the drive rods in the accelerating cell was obtained. This force can be corrected by a weak static magnetic

quadrupole provided the current in the drive rods is constant. The octopole force produced by a 4-hole diagnostic section was also obtained. A new recessed cathode design was modeled using PBGUNS. For a 2 mm recess, the electrostatic focusing due to the recess is sufficient to stop current loss on the anode. The emitted and transported currents are in good agreement with the measured values. The LAMDA code was compared in detail to the LLNL code BREAKUP. The codes are in close agreement. To get the results to overlay identically, however, the beam voltages have to differ by about 100 kV (out of 3 MV). The source of this discrepancy has not yet been identified. A plotting utility for LAMDA was written in the IDL® language. This allows LAMDA output to be viewed on any platform supported by IDL. Experiments on the flat-cathode injector were modeled. Beam radius as a function of magnet strength was compared in detail with measurements, and good agreement was obtained. The effect of the trim coil on reducing beam emittance was investigated further. The trim coil allows one to correct emittance growth due to spherical aberration in the focusing magnet and nonlinear self forces. The measured calibrations for the bucking, focus and trim coils are now in good agreement with the calculated values. A code which optimizes the transport magnet settings was developed. The code iterates on the magnet settings to obtain a beam envelope with some user-specified properties. This procedure may be useful in tuning the ITS or DARHT linacs.

30452 (LA-UR–95-1578) **High brightness electron sources.** Sheffield, R.L. Los Alamos National Lab., NM (United States). [1995]. 6p. Sponsored by USDOE, Washington, DC (United States). DOE Contract W-7405-ENG-36. (CONF-950512–310: Particle accelerator conference, Dallas, TX (United States), 1-5 May 1995). Order Number DE95015290. Source: OSTI; INIS; NTIS; GPO Dep.

High energy physics accelerators and free electron lasers put increased demands on the electron beam sources. This paper describes the present research on attaining intense bright electron beams using photoinjectors. Recent results from the experimental programs will be given. The performance advantages and difficulties presently faced by researchers will be discussed, and the following topics will be covered. Progress has been made in photocathode materials, both in lifetime and quantum efficiency. Cesium telluride has demonstrated significantly longer lifetimes than cesium antimonide at 10^{-8} torr. However, the laser system is more difficult because cesium telluride requires quadrupled YLF instead of the doubled YLF required for cesium antimonide. The difficulty in using photoinjectors is primarily the drive laser, in particular the amplitude stability. Finally, emittance measurements of photoinjector systems can be complicated by the non-thermal nature of the electron beam. An example of the difficulty in measuring beam emittance is given.

30453 (LA-UR–95-1793) **High-power RF operations studies with the CRITS RFQ.** Bolme, G.O. (and others); Keffeler, D.R.; Brown, V.W. Los Alamos National Lab., NM (United States). 1995. 4p. Sponsored by USDOE, Washington, DC (United States). DOE Contract W-7405-ENG-36. (CONF-950512–312: Particle accelerator conference, Dallas, TX (United States), 1-5 May 1995). Order Number DE95016430. Source: OSTI; NTIS; INIS; GPO Dep.

High-current, cw linear accelerators have been proposed as spallation neutron source drivers for applications to tritium production, transmutation of nuclear waste, and safe nuclear power generation. Key features of these accelerators are high current (100 mA) low emittance-growth beam propagation, cw or high duty-factor operation, high efficiency, and minimal maintenance downtime. A 267.1 MHz, cw RFQ and klystrode based RF system were obtained from CRL and installed at LANL to support these next generation accelerator studies. The reconditioning of the RFQ accelerator section to its design power of 150 kW at 100% duty factor is being accomplished with studies focusing on the details of high-power RF structure operation, personnel and equipment safety systems integration, and RF controls integration.

30454 (LA-UR–95-3061) **Static and dynamic analysis of the APT superconducting cavities.** Schrage, D.; Swensen, E.; Rusnak, B. Los Alamos National Lab., NM (United States). [1995]. 8p. Sponsored by USDOE, Washington, DC (United States). DOE Contract W-7405-ENG-36. (CONF-9510220–1: 7. workshop on RF superconductivity, Paris (France), 17-20 Oct 1995). Order Number DE96000071. Source: OSTI; NTIS; INIS; GPO Dep.

Static and dynamic analysis of 4-, 6-, and 12-cell β=0.428 niobium cavities proposed for the superconducting linac for the Accelerator Production of Tritium were carried out using COSMOS/M©, a commercial finite-element code. The benefits of external stiffeners, the tuning sensitivities, and the mechanical resonant frequencies are reported.

30455 (LA-UR–95-3091) **Microwave proton source development for a high-current linac injector.** Sherman, J. (Los Alamos National Lab., NM (United States). Accelerator Operations and Technology Div.); Bolme, G.; Geisik, C. Los Alamos National Lab., NM (United States). [1995]. 15p. Sponsored by USDOE, Washington, DC (United States). DOE Contract W-7405-ENG-36. (CONF-9509125–1: 6. international conference on ion sources, Whistler (Canada), 10-16 Sep 1995). Order Number DE96000050. Source: OSTI; NTIS; INIS; GPO Dep.

Powerful CW proton linear accelerators (100-mA at 0.5–1.0 GeV) are being proposed for spallation neutron-source applications. A 75-keV, 110-mA dc proton injector using a microwave ion source is being tested for these applications. It has achieved 80-keV, 110-mA hydrogen-ion-beam operation. Video and dc beam-current toroid diagnostics are operational, and an EPICS control system is also operational on the 75-keV injector. A technical base development program has also been carried out on a 50-keV injector obtained from Chalk River Laboratories, and it includes low-energy beam transport studies, ion source lifetime tests, and proton-fraction enhancement studies. Technical base results and the present status of the 75-keV injector will be presented.

30456 (LA-UR–95-3102) **Subpicosecond compression experiments at Los Alamos National Laboratory.** Carlsten, B.E. (and others); Russell, S.J.; Kinross-Wright, J.M. Los Alamos National Lab., NM (United States). 1995. 40p. Sponsored by USDOE, Washington, DC (United States). DOE Contract W-7405-ENG-36 ; AC08-93NV11265. (EGG–11265-5045; CONF-9509227–1: MicroBunches workshop, Upton, NY (United States), 28-30 Sep 1995). Order Number DE96000047. Source: OSTI; NTIS; GPO; GPO Dep.

The authors report on recent experiments using a magnetic chicane compressor at 8 MeV. Electron bunches at both low (0.1 nC) and high (1 nC) charges were compressed from 20 ps to less than 1 ps (FWHM). A transverse deflecting rf cavity was used to measure the bunch length at low charge; the bunch length at high charge was inferred from an induced energy spread of the beam. The longitudinal centrifugal-space charge force is calculated using a point-to-point numerical simulation and is shown not to influence the energy-spread measurement.

30457 (LA-UR–95-3166) **Development of a toroidal-filter H^- ion source.** Stevens, R.R. Jr.; York, R.L.; Geisik, C.; Swenson, D.R. Los Alamos National Lab., NM (United States). [1995]. 16p. Sponsored by USDOE, Washington, DC (United States). DOE Contract W-7405-ENG-36. (CONF-9509125–2: 6. international conference on ion sources, Whistler (Canada), 10-16 Sep 1995). Order Number DE96000036. Source: OSTI; NTIS; INIS; GPO Dep.

High brightness H^- ion beams will be required for the next generation of accelerator-driven, neutron spallation sources. Volume H^- ion sources have the potential for providing these beams at high duty factor with moderate beam currents and with the long-term operational stability and reliability needed. The authors report on the results of a continuing study of the LANL version of a toroidal-filter, volume H^- ion source which was designed to provide such beams. The H^- beam current, emittance, and electron loading have been measured with the source equipped with a 3-mm and a 10-mm dia. emission aperture and with several configurations of the plasma filter. The results are compared to beam simulations.

30458 (LA-UR–95-17922, pp. 338-344) **Proton-beam window design for a transmutation facility operating with a liquid lead target.** Jansen, C. (Institute for Safety Research and Reactor Technology, Juelich (Germany)); Lypsch, F.; Lizana, P. Los Alamos National Lab., NM (United States). [1995]. (CONF-9407103–: International conference on accelerator-driven transmutation technologies and applications, Las Vegas, NV (United States), 25 Jul -

1 aug 1994). In *AIP conference on accelerator driven transmutation technologies and applications, Los Vegas, Nevada, July 25-29, 1994.* 958p. Order Number DE95014018. Source: OSTI; NTIS; INIS.

The proton beam target of an accelerator-driven transmutation facility can be designed as a vertical liquid lead column. To prevent lead vapor from entering the accelerator vacuum, a proton-beam window has to separate the area above the lead surface from the accelerator tube. Two radiation-cooled design alternatives have been investigated which should withstand a proton beam of 1.6 GeV and 25 mA. Temperature calculations based on energy deposition calculations with the Monte Carlo code HETC, stability analysis and spallation-induced damage calculations have been performed showing the applicability of both designs.

30459 (LA-UR–95-17922, pp. 345) **Evaluations for the choice of the best target material in a accelerator-driven reactor.** Neuhold, P. Los Alamos National Lab., NM (United States). [1995]. (CONF-9407103–: International conference on accelerator-driven transmutation technologies and applications, Las Vegas, NV (United States), 25 Jul - 1 aug 1994). In *AIP conference on accelerator driven transmutation technologies and applications, Los Vegas, Nevada, July 25-29, 1994.* 958p. Order Number DE95014018. Source: OSTI; NTIS; INIS.

From the point of view of the overall credibility of the machine the choice of the best target material play a fundamental role. That has to fulfill at least three requirements: (1) the maximum number of neutrons produced per incident proton; (2) the maximum melting point; (3) the minimum activation under neutron irradiation. A number of different candidates can be investigated, keeping in mind that the first requirement is roughly fulfilled by high atomic number elements: the most popular among them appear to be W, Pb, and Np. While the characteristics for the second point are well known (3410C, 327C and 640C), as well as many evaluations are done about the first point, even if showing numbers ranging roughly a factor of 2 between the lowest and the highest ones, poor attention instead has been given to the third one. As far as the operation/maintenance of the machine is concerned, is important to know the dose rate of the target due to its neutron activation. According to the author's calculations, for example after one year of 800 MeV/62.5 mA proton irradiation of W, one can have, after one day of decay, dose rates as high as 2*10**6 Sv/hr, cumulative of the effects due to the direct proton beam and to the arising neutron flux. The author made use of the codes MSMPN, ANITA for the neutron activation analysis and of NMTC, ORIGEN for the proton interaction analysis. In particular it's worth noting how dramatic differences can arise from different isotopic composition, that is for example between natural W or only W-186, due to the very different behavior of the daughter elements as decay time and gamma-energy. For example the dose rate due to the neutron activation alone, after one month of decay, for natural W is a factor of 500 greater than for W-186.

30460 (LA-UR–95-17922, pp. 465-474) **Basic aspects of spallation radiation damage to materials.** Wechsler, M.S. (North Carolina State Univ., Raleigh, NC (United States)); Lin, C.; Sommer, W.F. Los Alamos National Lab., NM (United States). [1995]. (CONF-9407103–: International conference on accelerator-driven transmutation technologies and applications, Las Vegas, NV (United States), 25 Jul - 1 aug 1994). In *AIP conference on accelerator driven transmutation technologies and applications, Los Vegas, Nevada, July 25-29, 1994.* 958p. Order Number DE95014018. Source: OSTI; NTIS; INIS.

The nature of radiation effects, as learned from investigations using reactor neutron irradiations, is reviewed, and its relevance to spallation radiation damage to materials in accelerator-driven neutron sources is discussed. Property changes upon irradiation are due to (1) displaced atoms, producing vacancy and interstitial defect clusters, which cause radiation hardening and embrittlement; (2) helium production, the helium then forming bubbles, which engenders high-temperature grain-boundary fracture; and (3) transmutations, which means that impurity concentrations are introduced. Methods for analyzing displacement production are related, and recent calculations of displacement cross sections using SPECTER and LAHET are described, with special reference to tungsten, a major candidate for a target material in accelerator-driven neutron systems.

30461 (LA-UR–95-17922, pp. 579-585) **Reliability and availability considerations in the RF systems of ATW-class accelerators.** Tallerico, P.J. (Los Alamos National Laboratory, NM (United States)); Lynch, M.T.; Lawrence, G. Los Alamos National Lab., NM (United States). [1995]. (CONF-9407103–: International conference on accelerator-driven transmutation technologies and applications, Las Vegas, NV (United States), 25 Jul - 1 aug 1994). In *AIP conference on accelerator driven transmutation technologies and applications, Los Vegas, Nevada, July 25-29, 1994.* 958p. Order Number DE95014018. Source: OSTI; NTIS; INIS.

In an RF-driven, ion accelerator for waste transmutation or nuclear material production, the overall availability is perhaps the most important specification. The synchronism requirements in an ion accelerator, as contrasted to an electron accelerator, cause a failure of an RF source to have a greater consequence. These large machines also are major capital investments, so the availability determines the return on this capital. RF system design methods to insure a high availability without paying a serious cost penalty are the subject of this paper. The overall availability goal in the present designs is 75% for the entire ATW complex, and from 25 to 35% of the unavailability is allocated to the RF system, since it is one of the most complicated subsystems in the complex. The allowed down time for the RF system (including the linac and all other systems) is then only 7 to 9% of the operating time per year, or as little as 613 hours per year, for continuous operation. Since large accelerators consume large amounts of electrical power, excellent efficiency is also required with the excellent availability. The availability also influences the sizes of the RF components; smaller components may fail and yet the accelerator may still meet all specifications. Larger components are also attractive, since the cost of an RF system usually increases as the square root of the number of RF systems utilized. In some cases, there is a reliability penalty that accompanies the cost savings from using larger components. The authors discuss these factors, and present an availability model that allows one to examine these trade offs, and make rational choices in the RF and accelerator system designs.

30462 (LA-UR–95-17922, pp. 610-615) **Specialized beam diagnostic measurements for an ADTT accelerator funnel.** Gilpatrick, J.D. Los Alamos National Lab., NM (United States). [1995]. (CONF-9407103–: International conference on accelerator-driven transmutation technologies and applications, Las Vegas, NV (United States), 25 Jul - 1 aug 1994). In *AIP conference on accelerator driven transmutation technologies and applications, Los Vegas, Nevada, July 25-29, 1994.* 958p. Order Number DE95014018. Source: OSTI; NTIS; INIS.

Los Alamos National Laboratory has proposed several CW-proton-beam facilities for accelerator-driven transmutation technologies (ADTT) with beam-current densities greater than 5 mA/mm^2. The primary beam-diagnostics-instrumentation requirement for these facilities is to provide sufficient beam information to understand and minimize beam-loss. To accomplish this task, the beam diagnostics instrumentation must measure beam parameters such as the projected centroids and profiles, total integrated current, and particle loss. Because of the high specific energy loss in materials at beam energies less than 20 MeV, interceptive measurements such as wire scanners or fluors cannot be used to determine beam profiles or centroids. Therefore, noninterceptive techniques must be used for on-line diagnosis of high-intensity CW beam at low energies. The beam funnel area of these proposed accelerator facilities provide a particular interesting beam measurement challenge. In this area of the accelerator, beam measurements must also sense how well the two funnel-input-beams are matched to each other in phase space. This paper will discuss some of the measurement requirements for these proposed accelerator facilities and the various noninterceptive techniques to measure dual-beam funnel operation.

30463 (LBL–35550) **Efficiency and stray light measurements and calculations of diffraction gratings for the ALS.** McKinney, W.R.; Mossessian, D.; Gullikson, E.; Heimann, P. Lawrence Berkeley Lab., CA (United States). Jul 1994. 18p. Sponsored by USDOE, Washington, DC (United States). DOE Contract

AC03-76SF00098. (CONF-940714–56: International meeting on synchrotron radiation instrumentation, Stony Brook, NY (United States), 18-22 Jul 1994). Order Number DE96001115. Source: OSTI; NTIS; INIS; GPO Dep.

Water cooled gratings manufactured for spherical grating monochromators of the Advanced Light Source beamlines 7.0, 8.0 and 9.0 were measured with the laser plasma source and reflectometer in the Center for X-ray Optics at LBL. The square-wave gratings are ion-milled into the polished electroless nickel surface after patterning by holographic photolithography. Absolute efficiency data are compared with exact electromagnetic theory calculation. Inter-order stray light and groove depths can be estimated from the measurements.

30464 (LBL–36342) **The "INVERSE PROBLEM" to the evaluation of the magnetic fields.** Caspi, S.; Helm, M.; Laslett, L.J. Lawrence Berkeley Lab., CA (United States). Jun 1995. 4p. Sponsored by USDOE, Washington, DC (United States). DOE Contract AC03-76SF00098. (CONF-950691–20: 14. international conference on magnet technology, Tampere (Finland), 11-16 Jun 1995). Order Number DE96001105. Source: OSTI; NTIS; INIS; GPO Dep.

In the design of superconducting magnet elements, such as may be required to guide and focus ions in a particle accelerator, one frequently premises some particular current distribution and then proceeds to compute the consequent magnetic field through use of the laws of Biot and Savart or of Ampere. When working in this manner one of course may need to revise frequently the postulated current distribution before arriving at a resulting magnetic field of acceptable field quality. It therefore is of interest to consider an alternative ("inverse") procedure in which one specifies a desired character for the field required in the region interior to the winding and undertakes then to evaluate the current distribution on the specified winding surface that would provide this desired field. By evaluating the specified potential in the region interior to the winding along the interface, the authors have determined that a relaxation solution to the potential in the region outside the winding can be converged and used to calculate wire location. They have demonstrated this method by applying a slightly modified version of the program POISSON to a periodic alternating sinusoidal quadrupole field.

30465 (LBL–36442) **Accelerator operation management using objects.** Nishimura, H.; Timossi, C.; Valdez, M. Lawrence Berkeley Lab., CA (United States). Apr 1995. 3p. Sponsored by USDOE, Washington, DC (United States). DOE Contract AC03-76SF00098. (CONF-950512–336: Particle accelerator conference, Dallas, TX (United States), 1-5 May 1995). Order Number DE96001107. Source: OSTI; NTIS; GPO Dep.

Conflicts over control of shared devices or resources in an accelerator control system, and problems that can occur due to applications performing conflicting operations, are usually resolved by accelerator operators. For these conflicts to be detected by the control system, a model of accelerator operation must be available to the system. The authors present a design for an operation management system addressing the issues of operations management using the language of Object-Oriented Design (OOD). A possible implementation using commercially available software tools is also presented.

30466 (LBL–36444) **Hysteresis and saturation effects with the ALS lattice magnets.** Keller, R. Lawrence Berkeley Lab., CA (United States). Apr 1995. 5p. Sponsored by USDOE, Washington, DC (United States). DOE Contract AC03-76SF00098. (CONF-950512–298: Particle accelerator conference, Dallas, TX (United States), 1-5 May 1995). Order Number DE95014798. Source: OSTI; NTIS; GPO Dep.

The primary purpose of the magnetic measurements performed on the ALS storage ring lattice magnets was to ascertain their compliance with the strict tolerances established for this third-generation synchrotron light source. In the course of the data evaluation, an approximation method has been developed that leads to four-parameter representations of all magnet transfer functions. The expressions for the transfer functions were now used to change the standard working point of the ALS storage ring from the upper to the lower hysteresis branches of all lattice magnet families, and later to ramp the ring from the customary 1.5 GeV to the maximum design energy of 1.9 GeV in one uninterrupted process that did not require any intermediate tune correction. This achievement is all the more remarkable as no remnant fields had directly been measured with any of these magnets. A specific remnant field effect that led to anomalous machine behavior-when trying to recuperate the betatron tunes on the lower hysteresis branch at standard energy could be ascribed to the C-shape of the quadrupole yokes.

30467 (LBL–36538) **Analysis and design modifications for upgrade of storage ring bump pulse system driving the injection bump magnets at the ALS.** Stover, G.D. Lawrence Berkeley Lab., CA (United States). Apr 1995. 3p. Sponsored by USDOE, Washington, DC (United States). DOE Contract AC03-76SF00098. (CONF-950512–342: Particle accelerator conference, Dallas, TX (United States), 1-5 May 1995). Order Number DE96001307. Source: OSTI; NTIS; INIS; GPO Dep.

A fast (4.0 ms half period) resonant discharge pulse system, using SCRs, was designed and constructed to drive the injection bump magnet system at the Advanced Light Source (ALS). The commissioning process revealed a high frequency resonance (T = 800 NS) superimposed on the driver discharge wave form. In addition, the peak amplitude of the magnet load recovery current exceeded design specifications. A SPICE analysis confirmed the suspected mechanisms for the parasitic ringing and the excessive load current "undershoot". This paper will address the subsequent analysis, measurements, and modifications carried out during the maintenance shutdown in June 1993.

30468 (LBL–36561) **Magnetic design of the advanced light source elliptical wiggler.** Marks, S.; Akre, J.; Hoyer, E.; Humphries, D.; Jackson, T.; Minamihara, Y.; Pipersky, P.; Plate, D.; Schlueter, R. Lawrence Berkeley Lab., CA (United States). Jun 1995. 4p. Sponsored by USDOE, Washington, DC (United States). DOE Contract AC03-76SF00098. (LSGN–215; CONF-950691–22: 14. international conference on magnet technology, Tampere (Finland), 11-16 Jun 1995). Order Number DE96001306. Source: OSTI; NTIS; INIS; GPO Dep.

An elliptical wiggler has been designed for installation in the Advanced Light Source at the Lawrence Berkeley Laboratory. The design has been optimized for the production of circularly polarized light in the 50 eV to 10 KeV energy range. The device will be 3.4 m long consisting of vertical and horizontal periodic structures. The period length for both is 20 cm. The vertical structure is a hybrid permanent magnet design which produces a peak field of 2.0 T. The horizontal magnetic structure is an iron core electromagnetic design shifted longitudinally by one-quarter period relative to the vertical structure; it has a peak field of 0.095 T. The polarity of the horizontal field can be switched at a rate of up to 1 Hz, which results in a modulation of the chirality of the circularly polarized radiation on-axis. This paper discusses the magnetic design and presents the results of radiation spectra calculations used for determining optimal field parameter settings.

30469 (LBL–36562) **Magnetic design of trim excitations for the advanced light source storage ring sextupole.** Marks, S. Lawrence Berkeley Lab., CA (United States). Jun 1995. 5p. Sponsored by USDOE, Washington, DC (United States). DOE Contract AC03-76SF00098. (CONF-950691–21: 14. international conference on magnet technology, Tampere (Finland), 11-16 Jun 1995). Order Number DE96001106. Source: OSTI; NTIS; GPO Dep.

The Advanced Light Source (ALS) storage ring sextupole is a unique multi-purpose magnet. It is designed to operate as a sextupole with three auxiliary trim modes: horizontal steering, vertical steering, and skew quadrupole. A perturbation theory for iron-dominated magnets developed by Klaus Halbach provides the basis for this design. The three trim excitations are produced by violating sextupole symmetry and are thus perturbations of the normal sextupole excitation. The magnet was designed such that all four modes are decoupled and can be excited independently. This paper discusses the use of Halbach's perturbation theory to design the trim functions and to evaluate the primary asymmetry in the sextupole mode, namely, a gap in the return yoke to accommodate the vacuum chamber.

30470 (LBL–36620) **Some ideas on the choice of designs and materials for cooled mirrors.** Howells, M.R. Lawrence

Berkeley Lab., CA (United States). Dec 1994. 22p. Sponsored by USDOE, Washington, DC (United States). DOE Contract AC03-76SF00098. (CONF-950261–5: Contribution for Halbach Festschrift, Berkeley, CA (United States), 3 Feb 1995). Order Number DE96001305. Source: OSTI; NTIS; INIS; GPO Dep.

This paper expresses some views on the fabrication of future synchrotron beam-line optics; more particularly the metallurgical issues in high-quality metal mirrors. A simple mirror with uniform cooling channels is first analyzed theoretically, followed by the cullular-pin-post system with complex coolant flow path. Choice of mirror material is next considered. For the most challenging situations (need for intensive cooling), the present practice is to use nickel-plated glidcop or silicon; for less severe challenges, Si carbide may be used and cooling may be direct or indirect; and for the mildest heat loads, fused silica or ulf are popular. For the highest performance mirrors (extreme heat load), the glidcop developments should be continued perhaps to cellular-pin-post systems. For extreme distortion, Si is indicated and invar offers both improved performance and lower price. For less extreme challenges but still with cooling, Ni-plated metals have the cost advantage and SXA and other Al alloys can be added to glidcop and invar. For mirrors with mild cooling requirements, stainless steel would have many advantages. Once the internal cooling designs are established, they will be seen as more cost-effective and reliable than clamp-on schemes. Where no cooling is needed, Si, Si carbide, and the glasses can be used. For the future, the effect of electroless Ni layers on cooling design need study, and a way to finish nickel that is compatible with multilayers should be developed.

30471 (LBL–37311) **Concept for a third generation ECR source at LBL.** Lyneis, C.M. (Lawrence Berkeley Lab., CA (United States). Nuclear Science Div.); Xie, Z.Q. Lawrence Berkeley Lab., CA (United States). Apr 1995. 5p. Sponsored by USDOE, Washington, DC (United States). DOE Contract AC03-76SF00098. (CONF-9504165–3: 12. international workshop on ECR ion sources, Riken (Japan), 25-27 Apr 1995). Order Number DE96000123. Source: OSTI; NTIS; INIS; GPO Dep.

Although the Advanced Electron Cyclotron Resonance ion source has produced record high charge state beams and is now in operation with the 88-Inch Cyclotron, development of a third generation ECR source could provide major new research opportunities at the 88-Inch Cyclotron. Higher intensities for particles with mass greater than 150 and energies above the Coulomb barrier would improve experiments using deep inelastic reactions to produce neutron rich compound nuclei that can be studied with the Gammasphere detector or its successor. Very high intensities (several particle μA from the cyclotron) for masses between 30 to 65 would greatly benefit the heavy element research. On the basis of on progress in ECR source development, a third generation ECR source with multiple-frequency microwave drives, enhanced magnetic mirror ratios and high secondary emission walls for additional cold electrons could extend the performance of the cyclotron into the areas described above and serve as a tool for ECR study.

30472 (LBL–37657) **High resolution soft x-ray bending magnet beamline 9.3.2 with circularly polarized radiation capability at the Advanced Light Source.** Hussain, Z. (Lawrence Berkeley Lab., CA (United States)); Heimann, P.A.; McKinney, W.; Padmore, H.A.; Huff, W.R.A.; Kellar, S.A.; Moler, E.J.; Fadley, C.S.; Shirley, D.A. Lawrence Berkeley Lab., CA (United States). Aug 1995. 4p. Sponsored by USDOE, Washington, DC (United States). DOE Contract AC03-76SF00098. (LSBL–277; CONF-950859–1: 11. international conference on vacuum ultraviolet radiation physics, Tokyo (Japan), 27 Aug - 1 sep 1995). Order Number DE96001304. Source: OSTI; NTIS; INIS; GPO Dep.

Bending magnet beamline 9.3.2 at the Advanced Light Source (ALS) was designed for high resolution spectroscopy in the soft x-ray energy region, covering a range from 30 eV to 1500 eV with three gratings. The monochromator itself is a standard fixed included angle 55 m spherical grating monochromator and was originally used at the Stanford Synchrotron Radiation Laboratory (SSRL) as a prototype for later insertion device based monochromators for the ALS. For operations at the ALS, the toroidal pre-mirror used at SSRL to vertically focus onto the entrance slit and horizontally focus onto the exit slit was replaced by two separate crossed mirrors (Kirkpatrick-Baez configuration). Circularly polarized radiation is obtained by inserting a water-cooled movable aperture in front of the vertically focusing mirror to allow selecting the beam either above or below the horizontal plane. To maintain a stable beam intensity through the entrance slit, the photocurrent signals from the upper and lower jaws of the entrance slit are utilized to set a feedback loop with the vertically deflecting mirror Piezoelectric drive. The beamline end station has a rotatable platform (through 60°) that accommodates two experimental chambers, enabling the synchrotron radiation to be directed to either one without breaking vacuum.

30473 (LS–176) **Specification of APS corrector magnet power supplies from closed orbit feedback considerations.** Emery, L.; Decker, G. Argonne National Lab., IL (United States). 6 Aug 1991. 9p. Sponsored by USDOE, Washington, DC (United States). DOE Contract W-31-109-ENG-38. Order Number DE95015496. Source: OSTI; NTIS; GPO Dep.

The goal of this report is to specify or confirm the strengths and resolutions of the corrector magnets and their power supplies. the photon beam must be stable to 5% of the phase space dimensions of the beam (10% of the emittance). Specification of the closed-orbit displacement in the insertion device appears in the CDR $\Delta\sigma_x < 16$ μm; $\Delta\sigma_{x'} < 1.2$ μrad; $\Delta\sigma_y < 4.4$ μm; $\Delta\sigma_{y'} < 0.45$ μrad. Global and local correction systems will remove DC and oscillatory components of the orbit distortion. The oscillatory orbit distortion is usually attributed to the ground motion coupling to the quadrupole supports, but one should not assume that ground motion is the unique source.

30474 (LS–188) **Specification of the power supply for a 6-pole combined horizontal and vertical corrector magnet.** Emergy, L. Argonne National Lab., IL (United States). 20 Feb 1992. 8p. Sponsored by USDOE, Washington, DC (United States). DOE Contract W-31-109-ENG-38. Order Number DE95015202. Source: OSTI; NTIS; INIS; GPO Dep.

Light Source Note LS-176 lists four types of corrector magnets and their power supply specifications. In order to simplify the AC operation of corrector magnets for closed orbit correction feedback, adopting a single type of corrector magnet for the whole ring is currently considered. This corrector magnet has six poles (an adaption from the ring sextupole magnet) and has coil windings producing independent horizontal and vertical bending fields. As in the other correctors, the vacuum chamber eddy current dominates the AC operation of the magnet which affects the voltage specification of the power supplies. In this note, the physical requirements of the magnets will be reviewed, and the relevant magnet and power supply parameters will be reported. A few assumptions on the local bump geometries have changed since the publication of LS-176. The inner correctors of the straight section bump have been moved about 0.15 m inwards to conform with current vacuum chamber design. This decreases the required magnet strengths by 15% relative to those in LS-176. As of the publication date of this report, the locations of the two outboard correctors of the straight section bump are set midway between the quadrupoles Q1 and Q2. Moving these correctors closer to the Q2's will further reduce the corrector strength required. Therefore, two results are presented: one with the two outward correctors remaining at their current design locations, and one with the outward correctors moved right up against quadrupole Q2. Also, the parameters for the bending magnet beamline bump are recalculated for a photon source placed 1/8th downstream of the entrance of the magnet.

30475 (LS–244) **Some thoughts on an eddy current septum magnet.** Halbach, K. (Argonne National Lab., IL (United States)). Argonne National Lab., IL (United States). [1995]. 29p. Sponsored by USDOE, Washington, DC (United States). DOE Contract W-31-109-ENG-38. Order Number DE95015830. Source: OSTI; NTIS; INIS; GPO Dep.

It is the purpose of this report to describe the thinking and work that went into thoroughly understanding, a specific eddy current septum magnet that will be used in the APS and needs "fixing." The goal is to go beyond mere qualitative understanding and carry the analysis far enough to recognize the real problems of this magnet and to develop the tools to solve them. While it would be very

tempting to write this report in very general terms, it would be very difficult to achieve complete generality, and one would risk losing the focus on this specific magnet that needs to have an improved performance. The discussion contains, however, so many generally useful concepts and procedures that it might further be useful for designers of other eddy current septum magnets both at the APS and elsewhere. Since it is necessary not only to have a deep qualitative understanding of several aspects of this type of magnet, but also to quantitatively assess what has to be done to achieve the desired performance, fairly heavy use of mathematical tools was made. In doing so it became clear that the extensive use of these tools is essential not only for this purpose, but also to get the required good qualitative understanding of the device. For instance, it turns out that in this particular instance, an important part of the underlying physics does not become clear until one seems to run into what one might consider, at first, a mathematical problem, whose resolution is not clear until one has found the solution, which then seems "obvious." Even though iron in the septum has a nonlinear relationship between B and H, assuming a constant permeability is sufficient to obtain the information needed to develop a sufficient understanding of the magnet to make some crucial decisions.

30476 (SLAC–95-6811) **A semi-automated system for the characterization of NLC accelerating structures.** Hanna, S.M.; Bowden, G.B.; Hoag, H.A.; Loewen, R.; Vlieks, A.E.; Wang, J.W. Stanford Linear Accelerator Center, Menlo Park, CA (United States). Jun 1995. 3p. Sponsored by USDOE, Washington, DC (United States). DOE Contract AC03-76SF00515. (CONF-950512–330: Particle accelerator conference, Dallas, TX (United States), 1-5 May 1995). Order Number DE95017720. Source: OSTI; NTIS; INIS; GPO Dep.

*A system for characterizing the phase shift per cell of a long X-band accelerator structure is described. The fields within the structure are perturbed by a small cylindrical metal bead pulled along the axis. A computer controls the bead position and processes the data from a network analyzer connected to the accelerator section. Measurements made on prototype accelerator sections are described, and they are shown to be in good agreement with theory.

30477 (SLAC-PUB–95-6676) **Design of a 50 MW klystron at X-band.** Wright, E. (and others); Callin, R.; Caryotakis, G. Stanford Linear Accelerator Center, Menlo Park, CA (United States). Jul 1995. 6p. Sponsored by USDOE, Washington, DC (United States). DOE Contract AC03-76SF00515. (CONF-9410218–10: Pulsed radio frequency sources for linear colliders, Long Island, NY (United States), 2-7 Oct 1994). Order Number DE95017366. Source: OSTI; NTIS; INIS; GPO Dep.

This paper describes the design and performance of the XL-1 klystron; a 50 MW klystron operating at a frequency of 11.424 GHz for use on the SLAC Next Linear Collider Test Accelerator (NLCTA). Problems associated with the development of high-power rf sources for NLC, and the solutions implemented on XL-1 are discussed.

30478 (SLAC-PUB–95-6798) **Impedance study for the PEP-II B-factory.** Heifets, S. (and others); Daly, C.E.; Ko, K. Stanford Linear Accelerator Center, Menlo Park, CA (United States). Jun 1995. 3p. Sponsored by USDOE, Washington, DC (United States). DOE Contract AC03-76SF00515. (CONF-950512–328: Particle accelerator conference, Dallas, TX (United States), 1-5 May 1995). Order Number DE95017718. Source: OSTI; NTIS; INIS; GPO Dep.

The paper summarizes results of the impedance studies of the components of the B-factory. The prime goal of this activity was to support the design of the vacuum chamber and, at the same time, to get a reasonable model of the machine impedance, which can be used later for detail studies of collective effects.

30479 (SLAC-PUB–95-6803) **Coupling impedance of a long slot and an array of slots in a circular vacuum chamber.** Stupakov, G.V. Stanford Linear Accelerator Center, Menlo Park, CA (United States). Jun 1995. 3p. Sponsored by USDOE, Washington, DC (United States). DOE Contract AC03-76SF00515. (CONF-950512–329: Particle accelerator conference, Dallas, TX (United States), 1-5 May 1995). Order Number DE95017719. Source: OSTI; NTIS; INIS; GPO Dep.

We find the real part of the longitudinal impedance for both a small hole and a long slot in a beam vacuum chamber with a circular cross section. The slot can be arbitrarily long; the only requirement on the dimensions of the slots is that its width be much smaller than c/w. Regular array of N slots periodically distributed along the pipe is also considered.

30480 (SSCL–673) **Beam position mismatching and correction of LEB-MEB transfer line.** Mao, N. (Superconducting Super Collider Lab., Dallas, TX (United States)); Gerig, R.; McGill, J.; Brown, K. Superconducting Super Collider Lab., Dallas, TX (United States). Jun 1994. 12p. Sponsored by USDOE, Washington, DC (United States). DOE Contract AC35-89ER40486. Order Number DE95011190. Source: OSTI; NTIS; INIS; GPO Dep.

The LEB-MEEB beam transfer line for the Superconducting Super Collider has ten dipoles, twenty four quadrupoles and three septum magnets. The effect of magnet misalignments and field errors on the beam position mismatching and emittance growth is analyzed statistically and a beam position correction scheme is given. The beam position correction of the related LEB absorber line is also discussed.

30481 (SSCL-Preprint–509-Rev.1) **Periodicity of crossover currents in a Rutherford-type cable subjected to a time-dependent magnetic field. Revision 1.** Akhmetov, A. (Superconducting Super Collider Lab., Dallas, TX (United States)); Devred, A.; Ogitsu, T. Superconducting Super Collider Lab., Dallas, TX (United States). Sep 1993. 28p. Sponsored by USDOE, Washington, DC (United States). DOE Contract AC35-89ER40486. Order Number DE95011221. Source: OSTI; NTIS; INIS; GPO Dep.

The behavior Of Rutherford-type cables under a time-dependent magnetic field is studied. Existing models are extended describing the currents flowing through the resistive contacts at the crossovers between the cable strands by considering crossover current distributions which are not uniform along the cable axis. The generalized system of equations are applied to a few cases of practical interest and show that, if not uniform, the crossover current distribution is periodic, with a period equal to the cable pitch length.

30482 (SSCL-SR–1029) **Report of the task force on radioactivation.** Superconducting Super Collider Lab., Dallas, TX (United States). Oct 1987. 74p. Sponsored by USDOE, Washington, DC (United States). DOE Contract AC35-89ER40486. Order Number DE95011091. Source: OSTI; NTIS; INIS; GPO Dep.

Estimates have been made of the residual radioactivation of the components of the SSC accelerator and detector complex. Such activation is caused by the loss of a small fraction of the proton beams being transported in the SSC accelerator system, by deliberate removal (dumping) of the beams and by particles created in the proton-proton collisions in the SSC storage rings. Existing methodology that has been successfully used to determine activation levels at other accelerator facilities has also been used to estimate the activation of SSC components in those cases where calculational methods may be applied. In addition, we have used measurements from existing accelerators, primarily the Fermilab and CERN accelerators, to provide the means to estimate activation for those cases in which calculational methods, such as Monte Carlo shower codes, are difficult to apply. We have also used these measurements to check the calculations from the shower codes where possible. We have estimated activation levels and dose rates, where possible, for the following components of the SSC: The abort dumps for both the storage rings and the elements of the injector system; beam Collimators and scrapers; magnets and other apparatus in the region of injection/extraction from one accelerator to another, target stations used to create test beams from the high energy booster; superconducting magnets in the high energy booster and the storage rings; and representative detector elements. We also briefly discuss aspects of handling or dismantling the components most significantly activated and the relevance to decommissioning of the SSC complex. A short description of the decommissioning of the Intersecting Storage Rings at CERN, the only pp collider that has been decommissioned, is included in this report.

30483 (SSC-SR–1018) **Report of the magnet length workshop.** Lawrence Berkeley Lab., CA (United States). SSC Central

Design Group. [1985]. 64p. Sponsored by USDOE, Washington, DC (United States). DOE Contract AC35-89ER40486. (CONF-8510523–: Magnet length workshop, Berkeley, CA (United States), 7-8 Oct 1985). Order Number DE95011081. Source: OSTI; NTIS; GPO Dep.

A meeting was held at the Central Design Group (CDG), to discuss magnet length and to recommend a length for the planned Conceptual Design Report (CDR) as well as for magnet R and D. This report is a summary of the findings. Included is the letter from C. Taylor, CDG, convening the meeting, the proposed agenda, a summary of the results, and an appendix containing information presented at the meeting. The discussion mainly centered around 4, 5, and 6 dipoles per (100 m) half-cell. The magnetic lengths are approximately 16.6 m per dipole (the ROS length as well as that of the first R and D magnet now under construction), 20.75 m for four dipoles per half-cell, and 13.8 m for six dipoles per half-cell. Cost estimates are given. The apparent cost advantage of the longer units could be partially offset if the aperture can be adjusted to take advantage of a more uniform average magnetic field that could be realized by sorting. This sorting can be more effective with 20% more (shorter) magnets in the machine.

30484 (SSC-SR–1023) **Cost estimate of initial SSC experimental equipment.** Lawrence Berkeley Lab., CA (United States). SSC Central Design Group. Jun 1986. 143p. Sponsored by USDOE, Washington, DC (United States). DOE Contract AC35-89ER40486. Order Number DE95011085. Source: OSTI; NTIS; GPO Dep.

The cost of the initial detector complement at recently constructed colliding beam facilities (or at those under construction) has been a significant fraction of the cost of the accelerator complex. Because of the complexity of large modern-day detectors, the time-scale for their design and construction is comparable to the time-scale needed for accelerator design and construction. For these reasons it is appropriate to estimate the cost of the anticipated detector complement in parallel with the cost estimates of the collider itself. The fundamental difficulty with this procedure is that, whereas a firm conceptual design of the collider does exist, comparable information is unavailable for the detectors. Traditionally, these have been built by the high energy physics user community according to their perception of the key scientific problems that need to be addressed. The role of the accelerator laboratory in that process has involved technical and managerial coordination and the allocation of running time and local facilities among the proposed experiments. It seems proper that the basic spirit of experimentation reflecting the scientific judgment of the community should be preserved at the SSC. Furthermore, the formal process of initiation of detector proposals can only start once the SSC has been approved as a construction project and a formal laboratory administration put in place. Thus an ad hoc mechanism had to be created to estimate the range of potential detector needs, potential detector costs, and associated computing equipment.

30485 (SSC-SR–1028) **Report of the Task Force on Collision Hall Limitations.** Lawrence Berkeley Lab., CA (United States). SSC Central Design Group. Apr 1987. 77p. Sponsored by USDOE, Washington, DC (United States). DOE Contract AC35-89ER40486. Order Number DE95011090. Source: OSTI; NTIS; GPO Dep.

The Task Force on Collision Hall Limitations met March 23–26, 1987, to obtain a greater understanding of the civil construction requirements for a large scale model SSC detector and to identify limitations, if any, on overall detector scale and individual detector components that may result from civil construction limitations. To this purpose the Task Force studied civil construction techniques and limitations for both deep sites and surface or near surface sites, developed limits and criteria for model detector assembly and servicing, developed a model detector assembly scenario, and estimated an overall schedule from initiation of the design of the experimental hall complex to the completion of the assembly of the model detector. Our conclusions apply only to facilities required to house experiments of the scale of the model detector studied. From our studies it is apparent that the experimental hall complex required for SSC-scale detectors can be constructed under a variety of assumptions regarding the eventual SSC site. There may be significant differences in the schedule and the cost of the experimental hall complex between surface and deep underground locations, with the deep underground, in general, being more expensive and requiring a longer time for construction. The difference in cost and schedule for the experimental facilities for housing the model detector between a surface site and a deep underground site may amount to $25M and two years.

30486 (SSC-SR–1036) **Report of the workshop on Siberian snakes for the SSC collider ring.** Yokoya, K. (Lawrence Berkeley Lab., CA (United States). SSC Central Design Group). Lawrence Berkeley Lab., CA (United States). SSC Central Design Group. Sep 1988. 43p. Sponsored by USDOE, Washington, DC (United States). DOE Contract AC35-89ER40486. (CONF-8809547–: Workshop on Siberian snakes for the SSC Collider ring, Berkeley, CA (United States), 7-8 Sep 1988). Order Number DE95011097. Source: OSTI; NTIS; GPO Dep.

This workshop on Siberian snakes for the SSC was held to discuss the technical feasibility of polarized beams at the SSC. Only the 20-TeV collider ring was discussed with the prospect that the polarized beam source, the linac, and the boosters have fewer technical problems. More specifically, the major issue of the mini-workshop was to give an answer to the questions (1) how many Siberian snakes are needed and (2) what alignment tolerances are required, given the snakes. No attempt was made to address the issues of whether polarized beams will benefit the SSC high energy physics program or what the cost will be. As for the two questions above, workshop participants concluded that the required number of snake pairs is around 10 and the alignment tolerance is less than 100 microns. This tight tolerance is of great concern and has to be confirmed by other means such as computer simulation. One of the conclusions was that they should have a realistic lattice of the SSC which enables them to study it in more detail and to try computer simulations.

30487 (UCRL-JC–119358) **Choppertron II.** Houck, T.L. (Lawrence Livermore National Lab., CA (United States)); Westenskow, G.A.; Haimson, J.; Mecklenburg, B. Lawrence Livermore National Lab., CA (United States). 25 Apr 1995. 3p. Sponsored by USDOE, Washington, DC (United States). DOE Contract W-7405-ENG-48 ; FG03-92ER81285. (CONF-950512–326: Particle accelerator conference, Dallas, TX (United States), 1-5 May 1995). Order Number DE96000390. Source: OSTI; NTIS; INIS; GPO Dep.

We present experimental results of a version of the Choppertron microwave generator designed to work with the high emittance beam of the Advanced Test Accelerator (ATA). Simulations showed that a 800-A, 120 π cm-mrad beam (typical of ATA), could produce 800 MW of rf (11.4 GHz) power using two 12-cell, traveling-wave output structures. Funding contraints prevented final tuning of the modulator system and limited the experiment to 530 MW in narrow pulses. Over 400 MW were extracted from a single output structure through fundamental waveguide. Beam breakup was successfully suppressed with >800 amperes transported through the extraction section.

30488 (UCRL-JC–119360) **Design of a relativistic klystron two-beam accelerator prototype.** Westenskow, G. (and others); Caporaso, G.; Chen, Y. Lawrence Livermore National Lab., CA (United States). [1995]. 3p. Sponsored by USDOE, Washington, DC (United States). DOE Contract W-7405-ENG-48 ; AC03-76SF00098. (LBL–37141; CONF-950512–325: Particle accelerator conference, Dallas, TX (United States), 1-5 May 1995). Order Number DE96000389. Source: OSTI; NTIS; INIS; GPO Dep.

We are designing an experiment to study physics, engineering, and costing issues of an extended Relativistic Klystron Two-Beam Accelerator (RK-TBA). The experiment is a prototype for an RK-TBA based microwave power source suitable for driving a 1 TeV linear collider. Major components of the experiment include a 2.5-MV, 1.5-kA electron source, a 11.4-GHz modulator, a bunch compressor, and a 8-m extraction section. The extraction section will be comprised of 4 traveling-wave output structures, each generating about 360 MW of rf power. Induction cells will be used in the extraction section to maintain the average beam energy at 5 MeV. Status of the design is presented.

30489 (UCRL-JC–119406) **Design and Analysis of a Wiggler Magnet Systems for the SLAC B-Factory LER.** Heim, J. (Lawrence Livermore National Lab., CA (United States)); Bertolini, L.; Fackler, O.; Kendall, M.; O'Conner, T.; Swan, T.; Zholents, A. Lawrence Livermore National Lab., CA (United States). 2 Jun 1995. 6p. Sponsored by USDOE, Washington, DC (United States). DOE Contract W-7405-ENG-48 ; AC03-76SF00098. (CONF-950691–19: 14. international conference on magnet technology, Tampere (Finland), 11-16 Jun 1995). Order Number DE96000082. Source: OSTI; NTIS; GPO Dep.

The Low Energy Ring (LER) of the PEP-II B-Factory will use wiggler magnet systems for emittance control and additional damping. The wiggler baseline is a set of 11 individual iron core, water cooled, dipole magnets designed operate at 1.6 T and generate 400 kW of synchrotron radiation. Space has been provided to add a second wiggler with additional 400 kW of synchrotron radiation if more damping is needed in the future. A copper vacuum chamber is used with continuous antechambers connected to both sides of the beam chamber via slots. Synchrotron radiation dump surfaces both antechambers. We describe the design and analysis of the wiggler magnets and the salient features of the vacuum chamber and dumps.

30490 (UCRL-JC–119582) **Development of solid-state induction modulators for high PRF accelerators.** Kirbie, H. (Lawrence Livermore National Lab., Livermore, CA (United States)); Hawkins, S.; Hickman, B. Lawrence Livermore National Lab., CA (United States). 5 Jul 1995. 10p. Sponsored by USDOE, Washington, DC (United States). DOE Contract W-7405-ENG-48. (CONF-950750–39: 10. Institute of Electrical and Electronics Engineers (IEEE) pulsed power conference, Albuquerque, NM (United States), 10-13 Jul 1995). Order Number DE95017853. Source: OSTI; NTIS; GPO Dep.

Researchers at the Lawrence Livermore National Laboratory and EG&G Energy Measurements are developing a new solid-state power system for two proposed accelerators. One of the accelerators is a circular arrangement of induction cells called a recirculator. It is designed to accelerate heavy ions for an inertial fusion study that proposes to substitute heavy-ion beams for laser beams as the driver for fusion targets. The other accelerator is a linear induction accelerator for electron beams called the Advanced Radiographic Machine (ARM). Both accelerators require their induction cells to be pulsed at a very high repetition frequency (prf) for a short burst containing 5 to 15 pulses. The recirculator has a pulse schedule that varies in pulse width from 1 μs to 400 ns and in prf from 50 to 150 kHz. The ARM accelerator has a pulse schedule that varies in pulse width from 1 μs to 200 ns and in prf from 150 kHz to 1 MHz. The need for complex pulse agility in these accelerators led the authors to examine solid-state switching components that have an on/off capability. The intrinsic speed of solid-state switching satisfies the high prf requirements, while the on/off switching action of some semiconductor devices enables the authors to select an arbitrary pulse width. To accommodate these requirements, they selected field effect transistors (FETs) as the preferred switching elements. The same FET switching technology applies to both accelerators due to their similar pulse requirements. However, these two accelerators differ greatly in peak power and prf range. For example, the power system for the ARM accelerator must supply over 3 kA of beam-current loading to a 150-kV induction cell. For the authors research, two full-scale prototypes were built - a 5-kV induction recirculator cell and a single 15-kV induction modulator for the ARM accelerator. The authors discuss the general network features that are common to both machines, followed by performance and modeling data.

4304 Storage Rings

Refer also to citation(s) 30359, 30360, 30384, 30397, 30413, 30421, 30426, 30427, 30428, 30430, 30431, 30432, 30433, 30474, 30478, 30489, 31354

30491 (BNL–61894) **A progress report on the g-2 storage ring magnet system.** Bunce, G. (and others); Cullen, J.; Danby, G. Brookhaven National Lab., Upton, NY (United States). [1995]. 4p. Sponsored by USDOE, Washington, DC (United States). DOE Contract AC02-76CH00016. (CONF-950691–16: 14. international conference on magnet technology, Tampere (Finland), 11-16 Jun 1995). Order Number DE95016570. Source: OSTI; NTIS; INIS; GPO Dep.

The 3.1 GeV muon storage ring for the g-2 experiment at Brookhaven National Laboratory hat three large solenoid magnets that form a continuous 1.451 tesla storage ring dipole with an average beam bond radius of 7.1 metors. In addition to the three storage ring solenoids, there is an inflector dipole with nested dipole coils that create very little stray magnetic field. A superconducting shield on the infractor gets rid of most of the remaining stray flux. This paper reports on the progress made on the storage ring solenoid magnet system and the inflector as of June 1995. The results of cryogenic system tests are briefly reported.

30492 (KEK–95-5) **Nonlinear behavior of the bunch length in electron storage rings.** Kim, Eun-San; Hirata, Kohji. National Lab. for High Energy Physics, Tsukuba, Ibaraki (Japan). May 1995. 30p. Order Number DE96701329. Source: OSTI; NTIS; INIS.

The equilibrium particle distribution of a bunch in electron storage rings is discussed with respect to some localized wake functions, such as the constant, δ' and δ wake functions, based on the Gaussian approximation. For constant and δ' cases, under certain conditions, several different states can stably coexist, including multi-periodic states with rather large periods, limit cycle and chaotic motion. When moving around parameter space, the system shows a transition/bifurcation which is not always reversible. In the system of the δ wake function, only the period-1 state can stably exist. (author).

30493 (LBL–36434) **Automated beam based alignment of the ALS quadrupoles.** Portmann, G.; Robin, D.; Schachinger, L. Lawrence Berkeley Lab., CA (United States). Apr 1995. 3p. Sponsored by USDOE, Washington, DC (United States). DOE Contract AC03-76SF00098. (CONF-950512–337: Particle accelerator conference, Dallas, TX (United States), 1-5 May 1995). Order Number DE96001108. Source: OSTI; NTIS; GPO Dep.

Knowing the electrical offset of the storage ring beam position monitors (BPM) to an adjacent quadrupole magnetic center is important in order to correct the orbit in the ring. The authors describe a simple, fast and reliable technique to measure the BPM electrical centers relative to the quadrupole magnetic centers. By varying individual quadrupole magnets and observing the effects on the orbit they were able to measure the BPM offsets in half the horizontal and vertical BPMs (48) in the ALS. These offsets were measured to an accuracy of better than 50μm. The technique is completely automated and takes less than 3 hours for the whole ring.

30494 (LBL–37307) **Status of the SLAC/LBL/LLNL B-factory and the BABAR detector.** Oddone, P. Lawrence Berkeley Lab., CA (United States). Oct 1994. 21p. Sponsored by USDOE, Washington, DC (United States). DOE Contract AC03-76SF00098. (CONF-9410248–5: 1994 international workshop on B physics, physics beyond the standard model at the B factory, Nagoya (Japan), 26-28 Oct 1994). Order Number DE96001310. Source: OSTI; NTIS; INIS; GPO Dep.

After a brief introduction on the physics reach of the SLAC/LBL/LLNL Asymmetric B-Factory, the author describes the status of the accelerator and the detector as of the end of 1994. At this time, essentially all major decisions have been made, including the choice of particle identification for the detector. The author concludes this report with the description of the schedule for the construction of both accelerator and detector.

30495 (LBL–37630) **Quasi-isochronous storage ring for enhanced FEL performance.** Ohgaki, H. (Lawrence Berkeley Lab., CA (United States)); Robin, D.; Yamazaki, Y. Lawrence Berkeley Lab., CA (United States). Aug 1995. 10p. Sponsored by USDOE, Washington, DC (United States);Japan Atomic Energy Research Inst., Tokyo (Japan). DOE Contract AC03-76SF00098. (CONF-9508156–2: Free electron laser conference, New York, NY (United States), 21-25 Aug 1995). Order Number DE96001104. Source: OSTI; NTIS; GPO Dep.

A compact storage ring is designed to be used as a driver for an FEL. This ring can be operated very close to zero momentum compaction factor (α) to increase the electron density and thus the gain

of the FEL. In order to control α with zero dispersion in the straight sections the authors use an inverted dipole located between the bending magnets and 4-families of quadrupoles. By using 3-families of sextupoles they can control the 2 transverse chromaticities and 2nd order momentum compaction. They find that the ring has sufficient dynamic aperture for good performance.

30496 (LS–174(ANL)) **Positron Accumulator Ring (PAR) power supply.** Fathizadeh, M. Argonne National Lab., IL (United States). [1995]. 17p. Sponsored by USDOE, Washington, DC (United States). DOE Contract W-31-109-ENG-38. Order Number DE95015544. Source: OSTI; NTIS; INIS; GPO Dep.

The Positron Accumulator Ring (PAR) consists of 8 dipole magnets connected in series. These magnets are energized via one 12-pulse dc power supply. The power supply consists of four phase controlled half-wave wye group converters. Each of the two half-wave converters are connected through an interphase transformer to obtain a full-wave converter with 120° conduction. The input voltage for these two half-wave converters are 180° apart. The two full-wave converters are connected in parallel through a third interphase transformer. This type of connection of the converters not only provides the required output current, it also improves the input power factor of the power supply. The output of the wye group converters is filtered through a passive L-R-C filter to reduce the ripple content of the output current. At low current values of the power supply the current ripple is high, thus a large filter is needed, which adds to the cost of the power supply, however at high output current levels, the current ripple is less severe. The large size of the filter can be reduced by adding an anti-parallel rectifier diode(D1) to the output of the power supply. A freewheeling diode(D2) is connected before the choke to circulate the current once the power supply is turned off. In order to measure the current in the magnet a high precision, low drift, zero flux current transductor is used. This transductor senses the magnet current which provides a feedback signal to control the gating of the converter's thyristors. A true 14 bit Digital to Analog Converter (DAC) is programmed by the control computer for the required current value, providing a reference for the current regulator. Fast correction of the line transients is provided by a relatively fast voltage loop controlled by a high gain slow response current loop.

30497 (LS–175) **Magnetic measurement data of the 0.8-m prototype quadrupole magnets for the APS storage ring.** Kim, S.H. Argonne National Lab., IL (United States). [1995]. 21p. Sponsored by USDOE, Washington, DC (United States). DOE Contract W-31109-ENG-38. Order Number DE95015573. Source: OSTI; NTIS; INIS; GPO Dep.

From magnetic measurement data of the two 0.8-m prototype quadrupole magnets (P-SRQ-1 and P-SRQ-2) and the study of the geometries for the pole-end bevels and pole chamfers, the following conclusions have been made. Mechanical stability of the magnet poles has been achieved by modification of the weld procedures between two quadrants of the magnets. Stability of the magnet-pole positions was measured optically and was also concluded from the fact that the allowed coefficients, mainly sextupole and octupole terms, were independent of the magnet excitation currents. Unallowed multipole field coefficients for the second magnet, without correction of the magnet-pole positions, are smaller than for the first magnet. The field gradient integrals of the two magnets at 400A differ by less than 5×10^{-4} for r = 2.5 cm. This indicates that an acceptable magnet assembly procedure has been established. The 2-D calculations and "body" measurements for allowed coefficients after the main field, b_5 and b_9, agree within 1.2×10^{-4} at r = 2.5 cm. This implies that the 2-D design geometry is basically correct and acceptable. As expected for a magnet with long and narrow poles, saturation effects of pole shims have been observed. In order to reduce fabrication cost for the end-plates, the geometries for the pole-end bevels and pole chamfers have been studied. By choosing a bevel angle of 61°, instead of 45°, it is possible to have acceptable allowed coefficients with dimensions of pole-chamfers up to 16.5 mm. This allows the design of the end-plate as one piece without removable pole-tip.

30498 (SLAC-PUB–95-6818) **Transient beam loading in the SLC Damping Rings.** Minty, M.G.; Siemann, R.H. Stanford Linear Accelerator Center, Menlo Park, CA (United States). May 1995. 6p. Sponsored by USDOE, Washington, DC (United States). DOE Contract AC03-76SF00515. (CONF-950512–316: Particle accelerator conference, Dallas, TX (United States), 1-5 May 1995). Order Number DE95017721. Source: OSTI; NTIS; INIS; GPO Dep.

Effects arising from heavy beam loading in the Stanford Linear Collider (SLC) Damping Rings are described. The stability of the rf system and particle beam is studied using a numerical model of the beam cavity interaction with multiple feedback loops. Nonlinearities of the power source are also considered. The effects of beam-induced transients and intensity jitter on the rf system are analyzed and used to determine stability tolerances for both high current and low current pulses.

30499 (SLAC-PUB–95-6954) **Crossing angle collision and lifetime: Simulations, analysis, measurements and more simulations.** Chen, T. Stanford Linear Accelerator Center, Menlo Park, CA (United States). Jul 1995. 7p. Sponsored by USDOE, Washington, DC (United States). DOE Contract AC03-76SF00515. (CONF-9505271–1: ICF workshop on beam-beam issues for multibunch, high-luminosity circular colliders, Dubna (Russian Federation), 18-20 May 1995). Order Number DE95017369. Source: OSTI; NTIS; INIS; GPO Dep.

To achieve the high luminosity required by heavy quark factories, multibunch operation is almost the only choice. The key to gain luminosity in multibunch operation is to reduce the bunch spacing. Therefore, colliding beams with a crossing angle becomes the favorite interaction region scheme. The introduction of a crossing angle in e^+e^- colliders causes non-linear coupling between horizontal motion and longitudinal motion. This is illustrated in Figure 1. The beam-beam kick occurs when the particle passes the center of the opposing bunch. The strength of the kick, $\Delta r' = F(r)$, is a nonlinear function of the distance, r, between the particle and the center of the opposite bunch. In head-on collisions, r is the transverse displacement, and the kick is in the transverse plane, so that the process is nonlinear but not influenced by the longitudinal motion. In collisions with a crossing angle, however, r is a function of longitudinal displacement, s, and the crossing angle, F, as well as transverse displacement. The distance r between the test particle and the bunch center can be written.

30500 (UCRL-JC–119082) **The PEP-II-Factory septum quadrupole magnets.** Swan, J.M. (Lawrence Livermore National Lab., CA (United States)); Harvey, A.R.; Holmes, R.H.; Kendall, C.M.; Yamamoto, R.M.; Yokota, Ted T.; Tanabe, J.T.; Schlueter, R.D. Lawrence Livermore National Lab., CA (United States). 2 Jun 1995. 10p. Sponsored by USDOE, Washington, DC (United States). DOE Contract W-7405-ENG-48. (CONF-950691–18: 14. international conference on magnet technology, Tampere (Finland), 11-16 Jun 1995). Order Number DE96000084. Source: OSTI; NTIS; GPO Dep.

The PEP-II B-Factory is presently engaged design and fabrication of several unique magnets referred to as septum quadrupoles. This family of magnets is required to contain a low energy beam of positrons (3.1 GeV) and a high energy electron beam (9.0 GeV) in adjacent beam pipes housed within a common magnet. One beam will be focused while the other passes through an almost field free region. To do this, an asymmetric magnet must be designed having a pure, high quality quadrupole field in the magnet aperture and an adjacent low field bypass channel. A current sheet or "septum" coil must be placed between these two regions to produce the desired magnetic results. Design of this high current density septum coil presents many challenges since space between the two vacuum beam pipes where the coil must reside is very limited. This paper will describe the overall design of the septum quadrupoles and the solutions employed to achieve the required magnetic performance.

30501 (UCRL-JC–119208) **Wiggler insertion of the PEP-II B-Factory LER.** Heim, J. (and others); Bertolini, L.; Dressler, J. Lawrence Livermore National Lab., CA (United States). Apr 1995. 3p. Sponsored by USDOE, Washington, DC (United States). DOE Contract W-7405-ENG-48. (CONF-950512–301: Particle accelerator conference, Dallas, TX (United States), 1-5 May 1995). Order Number DE95017035. Source: OSTI; NTIS; INIS; GPO Dep.

The Low Energy Ring (LER) of the PEP-II B Factory at SLAC employs two identical wiggler insertions for emittance control and extra damping with each insertion designed to absorb 400 kW of

synchrotron radiation. The wiggler is a set of individual iron core dipoles designed to operate at 1.6 T. The basic variant will include nine 0.4-m length magnets and two 0.2-m length magnets. A copper vacuum chamber is used with continuous antechambers connected to both sides of the beam chamber via slots. Synchrotron radiation dump surfaces and distributed vacuum pumping are located in both antechambers. We describe the design and analysis of the vacuum chamber, dump and magnets.

44 INSTRUMENTATION

Refer also to citation(s) 31318

4401 Radiation Instrumentation

Refer also to citation(s) 28863, 28980, 29165, 29166, 29179, 30107, 30203, 30359, 30360, 30412, 30451, 30494, 30604, 30643, 30644, 30670, 30703, 30826, 30993, 31016, 31018, 31030, 31031, 31084, 31087, 31088, 31352

30502 (ANSTO/E–718) **High sensitivity two filter radon/thoron detectors with a wire or nylon screen as a second filter.** Whittlestone, S. (Australian Nuclear Science and Technology Organisation, Lucas Heights, NSW (Australia)); Zahorowski, W.; Wasiolek, P. Australian Nuclear Science and Technology Organisation, Lucas Heights, NSW (Australia). Dec 1994. 22p. Order Number DE96602734. Source: OSTI; NTIS; INIS.

A study is made of the use of wire and nylon screens as a second filter in two radon or thoron detectors. It is shown that acceptable detection efficiency is obtained at flow rates comparable to those used in detectors in which other types of filter are used. The main advantage of the screens is their very low flow impedance. Several designs of detector which exploit this feature are discussed. Details are given of the performance of three prototypes: a 32 L radon detector with a limit of detection of 0.0027 Bq m^{-3} and power consumption of 25 watts; and a portable thoron emanometer capable of detecting fluxes as low as 1 m Bq m^{-2} s^{-1}. The radon detectors are rugged and simple. They can operate with no routine maintenance and are suited to remote locations where only infrequent technical support is available. 14 refs., 2 tabs., 9 figs.

30503 (BNL–62065) **The ring imaging Cerenkov detector for the BRAHMS experiment at RHIC.** Debbe, R.; Gushue, S.; Moskowitz, B.; Olness, J.; Videbaek, F. Brookhaven National Lab., Upton, NY (United States). 1 Aug 1995. 9p. Sponsored by USDOE, Washington, DC (United States). DOE Contract AC02-76CH00016. (CONF-9506250–1: RICH '95: workshop on ring imaging detectors, Uppsala (Sweden), 12-16 Jun 1995). Order Number DE95016502. Source: OSTI; NTIS; INIS; GPO Dep.

A ring-imaging Cerenkov counter, to be read out by four 100-channel PMT'S, is a key element of the BRAHMS Experiment. We report here the most recent results obtained with a prototype tested at the BNL AGS using several radiator gases, including the heavy fluorocarbon C_4F_{10}. Ring radii were measured for different particles π^-, μ^-, e^- for momenta ranging from 2 to 12 GeV/c employing pure C_4F_{10} as radiator.

30504 (CNIC–00925) **Compound semiconductor GaAs and CdTe nuclear radiation detectors.** Ding Honglin (Academia Sinica, Beijing, BJ (China). Inst. of Atomic Energy); Zhang Xiufeng; Zhang Wanchang; Li Jiang. China Nuclear Information Centre, Beijing, BJ (China). Jan 1995. 9p. (IAE–0141.). Order Number DE96602015. Source: OSTI; NTIS (US Sales Only); INIS.

The preparation technology and characteristics of semi-insulating bulk single crystal GaAs surface-barrier detectors and single crystal CdTe surface-barrier detectors are described. The spectroscopic performance of the detectors for γ-rays from ^{125}I, ^{241}Am and ^{57}Co at room temperature is given. The influence of the magnitude of forward resistive induced by ohmic contacts and of the surface passivation and aging in the fabrication process of surface-barrier detectors on the performance of the detectors is discussed. Finally, the influence of the fabrication technology of ohmic contacts and selected materials, such as Ni-Ge-Au and In-Ge-Ag, on the performance of the detectors is also studied.

30505 (DOE/NV/11630–T1) **Advanced semiconductor detector development: Development of a room-temperature, gamma ray detector using gallium arsenide to develop an electrode detector. Progress report, September 30, 1994–September 29, 1995.** Knoll, G.F. Michigan Univ., Ann Arbor, MI (United States). Dept. of Nuclear Engineering. Jul 1995. 30p. Sponsored by USDOE, Washington, DC (United States). DOE Contract FG08-94NV11630. Order Number DE96001130. Source: OSTI; NTIS; INIS; GPO Dep.

Devices fabricated from wide bandgap materials that can be operated without cooling suffer from poor energy resolution and are limited to very small volumes; this arises largely from poor hole mobility in compound semiconductors. Three different device configurations are being investigated for possibly overcoming this limitation: buried grid-single carrier devices, trenched single carrier devices, and devices using patterned coplanar electrodes (CdZnTe). In the first, leakage problems were encountered. For the second, a set of specifications has been completed, and electron cyclotron resonance etching will be done at an off-campus facility. For the third, Aurora will supply 3 different CdZnTe detectors. An analytical study was done of the patterned electrode approach.

30506 (DOE/OR/21400–T496) **Optical imaging of charged particle tracks in a gas. Final report.** Turner, J.E. (Oak Ridge National Lab., TN (United States)); Hamn, R.N.; Hunter, S.R.; Gibson, W.A.; Hurst, G.S.; Wright, H.A. Oak Ridge National Lab., TN (United States). 28 Sep 1995. 20p. Sponsored by USDOE, Washington, DC (United States). DOE Contract AC05-84OR21400. Order Number DE96000677. Source: OSTI; NTIS; INIS; GPO Dep.

The development of a new detector designed to optically image the track of a charged particle in a gas is outlined. In the detector, a pulsed high-voltage (up to $\approx$ 30–40 kV), high-frequency (f = 27.125 MHz) RF field is temporarily applied (pulse duration $\approx$ 1–3 μs) across a pair of electrodes, immediately following, or alternatively, just prior to the passage of a charged particle through the chamber. The pulsed RF field excites the subexcitation electrons left along the particle's path leading to excitation and ionization of the surrounding gas and the emission of light. The track is then imaged by a fast intensified digital camera (shutter speed $\approx$ 0.1–5 μs). The image is recorded in a two-dimensional pixel array (512 $\times$ 512 pixels) within the camera, and transferred to a computer for later analysis. The detector has been operated over the total gas pressure range 2.5–100 kPa (20–750 torr) using a gas mixture of 2–10% N2 in Ar. Images of both α and β tracks obtained with this detector are discussed to demonstrate the usefulness of the present technique in charged-particle track analysis for dosimetry and microdosimetry applications.

30507 (EGG–11265-5019) **Position sensitivity in gallium arsenide radiation detectors.** Harper, R.; Hilko, R.A. EG and G Energy Measurements, Inc., Los Alamos, NM (United States). Los Alamos Operations. [1994]. 6p. Sponsored by USDOE, Washington, DC (United States). DOE Contract AC08-93NV11265. (CONF-941061–21-Vugraphs: Nuclear science symposium: medical imaging conference, Norfolk, VA (United States), 30 Oct - 5 nov 1994). Order Number DE96000163. Source: OSTI; NTIS; INIS; GPO Dep.

For several years, the authors have studied the electrical output of GaAs detectors in response to MeV protons. Beams from the Los Alamos National Laboratory's tandem Van de Graaff, bunched into pulses of about 0.7-ns width, have been used to drive detectors into the current mode, and fast electronics have enabled characterization of the impulse response shapes and the absolute sensitivities. Recently, the authors extended this line of investigation to measure output-charge spectra in response to low-current beams, in which the count rate was low and pulses due to individual ionizing particles were analyzed. The first part of the work was the measurement of spectra of the output charge of the detectors when bombarded by a beam of MeV-energy protons, which was collimated to a diameter of 0.1 mm. The GaAs detector was mounted on a microadjustable stage just behind the collimator, so that the site of irradiation on the detector could be varied. Output pulses originating from the impacts of individual protons were preamplified with charge-sensitive Lecroy 2004 preamplifiers, shaped with Lecroy 2011 amplifiers, and analyzed with a Lecroy

3500 multichannel analyzer. The second part was the measurement of the time response of the detector to a 0.1 mm-collimated bunched proton beam. The proton bunch width was less than 1 ns, during which time many protons struck the detector, driving it into the current mode where individual proton impacts are unresolved. A possible detector design is suggested by the results. In the past, GaAs time response has been improved by doping or radiation damaging, which introduces traps. The tails can be eliminated, but at the cost of a factor of a thousand in main peak sensitivity. It now appears that by masking off the region of the detector near the negative electrode, the tails can be eliminated with only a factor of about ten loss in peak gain.

30508 (FNAL/C–95/141-E) **Using modern software tools to design, simulate and test a Level 1 trigger sub-system for the D Zero Detector.** Angstadt, R. (Fermi National Accelerator Lab., Batavia, IL (United States)); Borcherding, F.; Johnson, M.E.; Moreira, L. Fermi National Accelerator Lab., Batavia, IL (United States). Jun 1995. 6p. Sponsored by USDOE, Washington, DC (United States). DOE Contract AC02-76CH03000. (CONF-950534–5: Conference on real-time computer applications in nuclear, particle and plasma physics (RT), East Lansing, MI (United States), 22-26 May 1995). Order Number DE95014574. Source: OSTI; NTIS; INIS; GPO Dep.

This paper describes a system which uses a commercial spreadsheet program and commercial hardware on an IBM PC to develop and test a track finding system for the D Zero Level 1 scintillating Fiber Trigger. The trigger system resides in a VME crate. This system allows the user to generate test input, write the pattern to the hardware simulate the results in software, read the hardware result: compare the results and inform the user of any differences.

30509 (FNAL/C–95/239-E) **Physics prospects with the upgraded CDF detector.** Hylen, J. CDF Collaboration. Fermi National Accelerator Lab., Batavia, IL (United States). Jul 1995. 13p. Sponsored by USDOE, Washington, DC (United States). DOE Contract AC02-76CH03000. (CONF-9508155–13: 17. international symposium on lepton-photon interactions, Beijing (China), 10-15 Aug 1995). Order Number DE95016199. Source: OSTI; NTIS; INIS; GPO Dep.

The CDF detector is being extensively upgraded for Fermilab Tevatron Run II, which is scheduled to begin in 1999. This talk describes the planned detector upgrades. The power of the upgraded detector is illustrated by showing the expected precision of several physics measurements that will be made with the Run II data: the top mass, the W mass, BR(t→Wb), and the CP violation parameters sin(2α) and sin(2β).

30510 (IC–95/132) **Oscillatory regime of avalanche particle detectors.** Lukin, K.A.; Cerdeira, H.A.; Colavita, A.A. International Centre for Theoretical Physics, Trieste (Italy). Jun 1995. 17p. Order Number DE96602042. Source: OSTI; NTIS (US Sales Only); INIS.

We describe the model of an avalanche high energy particle detector consisting of two pn-junctions, connected through an intrinsic semiconductor with a reverse biased voltage applied. We show that this detector is able to generate the oscillatory response on the single particle passage through the structure. The possibility of oscillations leading to chaotic behaviour is pointed out. (author). 15 refs, 7 figs.

30511 (IFVE-OEF–94-26) **Purification methods of styrene for plastic scintillators.** Lapshin, V.G.; Peresypkin, A.I.; Rykalin, V.I.; Spiridonov, P.N.; Alimova, T.V.; Morozova, V.V. Gosudarstvennyj Komitet po Ispol'zovaniyu Atomnoj Ehnergii SSSR, Serpukhov (Russian Federation). Inst. Fiziki Vysokikh Ehnergij. 1994. 4p. (In Russian). Order Number DE96602030. Source: OSTI; NTIS (US Sales Only); INIS.

The measurement results of light absorption lengths of scintillation polystyrene bars and styrene, purified with different methods, are presented. Aluminium oxide absorption column and/or vacuum distillation were used for purification of styrene. The methods are discussed and compared. 6 refs.; 1 fig.

30512 (INIS-BR–3540, pp. 122-125) **Aspects of cosmic neutrino and dark matter detection.** Simonetti, R. (Sao Paulo Univ., SP (Brazil). Inst. de Fisica); Escobar, C. Sociedade Brasileira de Fisica, Sao Paulo, SP (Brazil). 1993. 251p. (In Portuguese). (CONF-9109557–: 12. national meeting on particle physics and fields, Caxambu (Brazil), 18-22 Sep 1991). In *Proceedings of the 12. National Meeting on Particle Physics and Fields.* Order Number DE96602594. Source: OSTI; NTIS; INIS.

The inelastic coherent scattering using composed target (macroscopic) for detecting particles candidate to dark matter, including neutrino, is studied. The phonon production out of thermal equilibrium was investigated by collective excitation of target (crystal). The produced phonon spectrum specially ballistic phonons (GHz-THz) which are easier to be detected was analysed. The possibility for using coherent states as initial state of the process was also investigated. (M.C.K.). 2 refs, 6 figs, 1 tab.

30513 (LA–12910-MS) **Evaluation of ANSI N42-17A by investigating the effects of temperature and humidity on the response of radiological instruments.** Clement, R.S. Los Alamos National Lab., NM (United States). Jun 1995. 170p. Sponsored by USDOE, Washington, DC (United States). DOE Contract W-7405-ENG-36. Order Number DE95015052. Source: OSTI; NTIS; GPO Dep.

The American National Standards Institute (ANSI) N42.17A-1989 standard's performance criteria and test methods has been evaluated by investigating the effects of temperature and humidity on the response of 105 portable direct-reading radiological instruments (45 beta-gamma survey meters, 32 neutron rem meters, 1O alpha contamination and 18 tritium-in-air monitors). The US Department of Energy (DOE) mandates the use of ANSI standards for the calibration and performance testing of radiological instruments, and requires that instruments be appropriate for existing environmental conditions. Random tests conducted in an environmental chamber determined the effects of temperatures ranging from −10°C to 50°C and humidity at levels of 40% RH and 95% RH on the response of a cross section of instruments used in routine health physics operations at Los Alamos. The following instruments were tested: Eberline RO-2 and RO-C ionization chambers, Eberline E-530 survey meter with the Model HP-C stainless steel Geiger-Muller (G) wall probe, Eberline PIC-6A and PIC-6B ion chambers, Eberline ESP-1 survey meter with the Model HP-260 pancake G detector, Ludlum 3 survey meter with the Model 44-6 stainless steel G wall probe, Eberline ESP-1, ESP-2 and PAR-4 survey meters with the neutron rem detector, Health Physics Instruments 2080 survey meter with the moderator detector, Ludlum 139 survey meter with the Model 43-32 air-proportional alpha detector, and the Overhoff 394-C, Johnston J-111 and J-110 tritium monitors. Experimental results encompass 1128 temperature tests (1269-hours exposure in the chamber) and 735 humidity tests (1890-hours exposure in the chamber). The study shows the standard's test requirement for temperature at or near the extreme conditions, and the standard's test requirement for humidity at 95% RH may be too restrictive for instruments used in the work environment.

30514 (LA-SUB–93-180) **Materials preparation and fabrication of pyroelectric polymer/silicon MOSFET detector arrays. Final report.** Bloomfield, P. (Drexel Univ., Philadelphia, PA (United States). Dept. of Materials Engineering). Los Alamos National Lab., NM (United States); Drexel Univ., Philadelphia, PA (United States). Dept. of Materials Engineering. 27 Mar 1992. 16p. Sponsored by USDOE, Washington, DC (United States). DOE Contract W-7405-ENG-36. Subcontract 9-X61-J5927-1. Order Number DE96000183. Source: OSTI; NTIS; INIS; GPO Dep.

The authors have delivered several 64-element linear arrays of pyroelectric elements fully integrated on silicon wafers with MOS readout devices. They have delivered detailed drawings of the linear arrays to LANL. They have processed a series of two inch wafers per submitted design. Each two inch wafer contains two 64 element arrays. After spin-coating copolymer onto the arrays, vacuum depositing the top electrodes, and polarizing the copolymer films so as to make them pyroelectrically active, each wafer was split in half. The authors developed a thicker oxide coating separating the extended gate electrode (beneath the polymer detector) from the silicon. This should reduce its parasitic capacitance and hence improve the S/N. They provided LANL three processed 64 element sensor arrays. Each array was affixed to a connector panel and selected solder pads of the common ground, the common

source voltage supply connections, the 64 individual drain connections, and the 64 drain connections (for direct pyroelectric sensing response rather than the MOSFET action) were wire bonded to the connector panel solder pads. This entails (64 + 64 + 1 + 1) = 130 possible bond connections per 64 element array. This report now details the processing steps and the progress of the individual wafers as they were carried through from beginning to end.

30515 (LA-UR–95-2657) **A 100 ps gated x-ray spectrometer.** Walsh, P.J.; Blake, R.L.; Caldwell, S.; Hockaday, M.; Chrien, R.; Smith, R.C. Los Alamos National Lab., NM (United States). [1995]. 10p. Sponsored by USDOE, Washington, DC (United States). DOE Contract W-7405-ENG-36. (CONF-950793–32: 40. annual meeting of the Society of Photo-Optical Instrumentation Engineers, San Diego, CA (United States), 9-14 Jul 1995). Order Number DE95016966. Source: OSTI; NTIS; GPO Dep.

Material opacities are of interest in many fields. We have developed a Bragg reflection spectrometer that is gated for imaging samples in a laser heated environment for opacity measurement. A micro-channel plate is coated with a photocathode material and a fast pulse is launched across it. Electrons are converted to photons in a phosphor and recorded on film. Optical gate pulse widths of 100 ps are achieved. Some optical pulse width and sensitivity enhancements are noted at launch and termination. Events of interest are 200 ps long. The framing window is approximately 250 ps in length. Timing jitter is a problem. The instrument timing networks have been examined, and the source of jitter is still unknown. Timing to 50 ps resolution is desired. Close in proximity to the laser-driven event leads to complications in shielding from hard x-rays, hot electrons and shock-driven damage. High Z materials provide shielding from hard x-rays. Magnets screen out hot electrons produced by laser-matter interactions Filters provide energy fiducials. PCD's provide high resolution timing measurements. Data is recorded on film in a specially designed film pack. The instrument is designed to be used in the NOVA Laser Facility at Lawrence Livermore National Laboratory.

30516 (LA-UR–95-3297) **PC/FRAM: New capabilities for the gamma-ray spectrometry measurement of plutonium isotopic composition.** Sampson, T.E.; Kelley, T.A.; Cremers, T.L.; Konkel, T.R.; Friar, R.J. Los Alamos National Lab., NM (United States). [1995]. 11p. Sponsored by USDOE, Washington, DC (United States). DOE Contract W-7405-ENG-36. (CONF-950923–8: 5. international conference on facility-safeguards interface, Jackson Hole, WY (United States), 24-30 Sep 1995). Order Number DE96001468. Source: OSTI; NTIS; INIS; GPO Dep.

We describe the new capability of and present measurement results from the PC/FRAM plutonium isotopic analysis code. This new code allows data acquisition from a single coaxial germanium detector and analysis over an energy range from 120 keV to above I MeV. For the first time we demonstrate a complete isotopic analysis using only gamma rays greater than 200 keV in energy. This new capability allows the measurement of the plutonium isotopic composition of items inside shielded or heavy-walled containers without having to remove the items from the container. This greatly enhances worker safety by reducing handling and the resultant radiation exposure. Another application allows international inspectors to verify the contents of items inside sealed, long-term storage containers that may not be opened for national security or treaty compliance reasons. We present measurement results for traditional planar germanium detectors as well as coaxial detectors measuring shielded and unshielded samples.

30517 (LBL–37082) **Utilization of photoconductive gain in a-Si:H devices for radiation detection.** Lee, H.K.; Drewery, J.S.; Hong, W.S.; Jing, T.; Kaplan, S.N.; Perez-Mendez, V. Lawrence Berkeley Lab., CA (United States). May 1995. 6p. Sponsored by USDOE, Washington, DC (United States). DOE Contract AC03-76SF00098. (CONF-950412–39: Spring meeting of the Materials Research Society (MRS), San Francisco, CA (United States), 17-21 Apr 1995). Order Number DE95014795. Source: OSTI; NTIS; INIS; GPO Dep.

The photoconductive gain mechanism in a-Si:H was investigated in connection with applications to radiation detection. Various device types such as p-i-n, n-i-n and n-i-p-i-n structures were fabricated and tested. Photoconductive gain was measured in two time scales: one for short pulses of visible light (<1 μsec) which simulates the transit of an energetic charged particle, and the other for rather long pulses of light (1 msec) which simulates x-ray exposure in medical imaging. We used two definitions of photoconductive gain: current gain and charge gain which is an integration of the current gain. We found typical charge gains of $3 \sim 9$ for short pulses and a few hundred for long pulses at a dark current level of 10 mA/cm^2. Various gain results are discussed in terms of the device structure, applied bias and dark current.

30518 (LBL–37243) **P-type silicon drift detectors.** Walton, J.T.; Krieger, B.; Krofcheck, D.; O'Donnell, R.; Odyniec, G.; Partlan, M.D.; Wang, N.W. Lawrence Berkeley Lab., CA (United States). Jun 1995. 22p. Sponsored by USDOE, Washington, DC (United States). DOE Contract AC03-76SF00098. (CONF-9505291–1: 7. European symposium on semiconductor detectors, Schloss Elmau (Germany), 7-10 May 1995). Order Number DE96001120. Source: OSTI; NTIS; INIS; GPO Dep.

Preliminary results on 16 CM^2, position-sensitive silicon drift detectors, fabricated for the first time on p-type silicon substrates, are presented. The detectors were designed, fabricated, and tested recently at LBL and show interesting properties which make them attractive for use in future physics experiments. A pulse count rate of approximately $8 \times I0^6$ s^{-1} is demonstrated by the p-type silicon drift detectors. This count rate estimate is derived by measuring simultaneous tracks produced by a laser and photolithographic mask collimator that generates double tracks separated by 50 μm to 1200 μm. A new method of using ion-implanted polysilicon to produce precise valued bias resistors on the silicon drift detectors is also discussed.

30519 (LBL–37310) **P-type silicon drift detectors: First results.** Wang, N.W.; Krieger, B.; Krofcheck, D. Lawrence Berkeley Lab., CA (United States). Jun 1995. 5p. Sponsored by USDOE, Washington, DC (United States). DOE Contract AC03-76SF00098. (CONF-941061–22: Nuclear science symposium: medical imaging conference, Norfolk, VA (United States), 30 Oct - 5 nov 1994). Order Number DE96001117. Source: OSTI; NTIS; INIS; GPO Dep.

We have fabricated a 4 cm $\times$ 4 cm, position-sensitive silicon drift detector using high purity, p-type silicon as the substrate. In this paper, we describe the double-sided planar process used to fabricate the detectors and the strategy used to suppress surface carrier inversion due to the presence of fixed positive charge at the Si/SiO_2 interface. The key issue in optimizing the fabrication process has been to minimize leakage currents and prevent breakdown at low voltages. Tests show that a drift signal can be measured across the entire length of the detector and that the transit time of the holes varies linearly with the position of the induced charge signal.

30520 (LBL–37582) **Structural and phonon transmission study of Ge-Au-Ge eutectically bonded interfaces.** Knowlton, W.B. (Univ. of California, Berkeley, CA (United States). Dept. of Materials Science and Mineral Engineering). Lawrence Berkeley Lab., CA (United States). Jul 1995. 180p. Sponsored by USDOE, Washington, DC (United States). DOE Contract AC03-76SF00098. Order Number DE96000116. Source: OSTI; NTIS; INIS; GPO Dep.

This thesis presents a structural analysis and phonon transparency investigation of the Ge-Au-Ge eutectic bond interface. Interface development was intended to maximize the interfacial ballistic phonon transparency to enhance the detection of the dark matter candidate WIMPs. The process which was developed provides an interface which produces minimal stress, low amounts of impurities, and insures Ge lattice continuity through the interface. For initial Au thicknesses of greater than 1,000 Å Au per substrate side, eutectic epitaxial growth resulted in a Au dendritic structure with 95% cross sectional and 90% planar Au interfacial area coverages. In sections in which Ge bridged the interface, lattice continuity across the interface was apparent. Epitaxial solidification of the eutectic interface with initial Au thicknesses $<$ 500 A per substrate side produced Au agglomerations thereby reducing the Au planar interfacial area coverage to as little as 30%. The mechanism for Au coalescence was attributed to lateral diffusion of Ge and Au in the liquid phase during solidification. Phonon transmission studies were performed on eutectic interfaces with initial Au thicknesses of 1,000 Å, 500 Å, and 300 Å per substrate side. Phonon imaging of eutectically bonded samples with initial Au

thicknesses of 300 Å/side revealed reproducible interfacial percent phonon transmissions from 60% to 70%. Line scan phonon imaging verified the results. Phonon propagation TOF spectra distinctly showed the predominant phonon propagation mode was ballistic. This was substantiated by phonon focusing effects apparent in the phonon imaging data. The degree of interface transparency to phonons and resulting phonon propagation modes correlate with the structure of the interface following eutectic solidification. Structural studies of samples with initial Au thickness of 1,000 Å/side appear to correspond with the phonon transmission study.

30521 (MLM–74) **Calorimetry research progress report, March 1–31,, 1948.** Eichelberger, J.F. Monsanto Chemical Co., Dayton, OH (United States). [1948]. 9p. Sponsored by USDOE, Washington, DC (United States). DOE Contract AC04-76DP00053. Order Number DE96001482. Source: OSTI; NTIS; GPO Dep.

Sixty-eight samples were assayed. The 5 calorimeters of type 30 were finished. Calorimeter 36, whose construction has been started, is an improved version of 30. A system of switches has been devised. A simple, fast, insensitive calorimeter for measuring high activity samples is being tested. The calculations on the half-life of postum were checked.

30522 (MLM–283) **Limitations and past applications of the cloud chamber.** Chaplin, R.L. Jr. Mound Lab., Miamisburg, OH (United States). 23 Mar 1949. 10p. Sponsored by USDOE, Washington, DC (United States). DOE Contract AC24-88DP43495. Order Number DE96001596. Source: OSTI; NTIS; GPO Dep.

The cloud chamber is a means of observing the path of ionizing radiation. It does not reveal the radiation directly, but gives a visible trail of the path along which the radiation has traveled. The trail is formed by vapor condensing upon pairs of ions remaining after an ionizing particle has passed through the medium. The mutual interaction among rays, atoms, nuclei, and particles, can be studied and measured with the aid of vapor trails. Measurements of changes in direction and range as recorded on the photographs may be interpreted in terms of changes in momentum and energy of the particles in these reactions. To obtain a precision measurement is difficult with a cloud chamber. The dependence of the apparatus upon a sudden gas expansion is certain to create distortions resulting from turbulence. Furthermore, since any radiation is subject to variations, precision measurements can be obtained only be the collection of numerous observations for statistical analysis. This document details the design, operation, and limitations of cloud chambers.

30523 (SLAC-PUB–95-6968) **Future high energy physics experiments using RICH detectors: The next generation.** Ratcliff, B.N. Stanford Linear Accelerator Center, Menlo Park, CA (United States). Aug 1995. 12p. Sponsored by USDOE, Washington, DC (United States). DOE Contract AC03-76SF00515. (CONF-9506250–2: RICH '95: workshop on ring imaging detectors, Uppsala (Sweden), 12-16 Jun 1995). Order Number DE96001022. Source: OSTI; NTIS; INIS; GPO Dep.

This report describes some features of the new detectors now being constructed for use in high energy physics experiments that utilize RICH counters as a central element. The scope of this discussion is limited only to experiments which have been formally approved for construction as follows: (1) BaBar at PEP-II, which contains a quartz radiator DIRC counter; (2) CLEO III at the CESR upgrade, which utilizes a LiF/TEA Fast RICH; and (3) HERA-B at HERA, which uses a gas radiator RICH with either a TMAE- or a CsI-based photon detector. These experiments have much in common; all emphasize B-physics, run at the luminosity frontier, and plan to take first data either in 1998 or 1999. This review begins with a discussion of the physics goals and experimental context, and then explore the designs which have been chosen to confront the experimental issues. Particular emphasis is placed on the design and expected performance of the RICH detectors in these systems. Due to space limitations, only a few of the recent R and D results not covered elsewhere at the conference can be presented.

30524 (SSC-SR–1039) **Proceedings of the workshop on triggering and data acquisition for experiments at the Supercollider.** Donaldson, R. (ed.). Lawrence Berkeley Lab., CA (United States). SSC Central Design Group. Apr 1989. 195p. Sponsored by USDOE, Washington, DC (United States). DOE Contract AC35-89ER40486. (CONF-8901118–: Workshop on triggering and data acquisition for experiments at the Superconducting Super Collider, Toronto (Canada), 16-19 Jan 1989). Order Number DE95011099. Source: OSTI; NTIS; GPO Dep.

This meeting covered the following subjects: triggering requirements for SSC physics; CDF level 3 trigger; D0 trigger design; AMY trigger systems; Zeus calorimeter first level trigger; data acquisition for the Zeus Central Tracking Detector; trigger and data acquisition aspects for SSC tracking; data acquisition systems for the SSC; validating triggers in CDF level 3; optical data transmission at SSC; time measurement system at SSC; SSC/BCD data acquisition system; microprocessors and other processors for triggering and filtering at the SSC; data acquisition, event building, and on-line processing; LAA real-time benchmarks; object-oriented system building at SSC; and software and project management. Selected papers are indexed separately for inclusion in the Energy Science and Technology Database.

30525 (UCRL-ID–121571, pp. Paper 2, 10 Pages) **Midrapidity measurements with the BRAHMS spectrometer.** Beavis, D. (Brookhaven National Lab., Upton, NY (United States)). Lawrence Berkeley Lab., CA (United States). 15 Jul 1995. DOE Contract AC02-76CH00016. (CONF-950198–: Physics with the collider detectors at Relavitistic Heavy Ion Collider (RHIC) and the LHC, Livermore, CA (United States), 8 Jan 1995). In *Physics with the collider detectors at RHIC and the LHC.* 212p. Order Number DE95015976. Source: OSTI; NTIS; INIS; GPO Dep.

The forward- and midrapidity-arms of the BRAHMS experiment are designed to measure charged particle production over a wide range of transverse momentum for rapidities, $0 \leq y \leq 4$. Details of the midrapidity spectrometer, which provides coverage for $0 \leq \eta \leq 1.3$, are presented here. The capabilities for inclusive π^{+-}, K^{+-}, and p^{+-} measurements and boson pair correlations are discussed.

30526 (UCRL-ID–121571, pp. Paper 3, 10 Pages) **Hadron distributions at higher rapidity using the BRAHMS forward spectrometer.** Moskowitz, B. (Brookhaven National Lab., Upton, NY (United States)). Lawrence Berkeley Lab., CA (United States). 15 Jul 1995. DOE Contract AC02-76CH00016. (CONF-950198–: Physics with the collider detectors at Relavitistic Heavy Ion Collider (RHIC) and the LHC, Livermore, CA (United States), 8 Jan 1995). In *Physics with the collider detectors at RHIC and the LHC.* 212p. Order Number DE95015976. Source: OSTI; NTIS; INIS; GPO Dep.

Different conditions, and therefore different physics, are expected to exist over the range of rapidities at RHIC. The BRAHMS Forward Spectrometer will measure identified hadron distributions up to y=4, giving it a unique place in the RHIC experimental program.

30527 (UCRL-ID–121571, pp. Paper 4, 9 Pages) **PHOBOS physics capabilities.** Baker, M.D. (Massachusetts Institute of Technology, Cambridge, MA (United States)). Lawrence Berkeley Lab., CA (United States). 15 Jul 1995. (CONF-950198–: Physics with the collider detectors at Relavitistic Heavy Ion Collider (RHIC) and the LHC, Livermore, CA (United States), 8 Jan 1995). In *Physics with the collider detectors at RHIC and the LHC.* 212p. Order Number DE95015976. Source: OSTI; NTIS; INIS; GPO Dep.

PHOBOS is the name of a detector and of a research program to study systematically the physics of relativistic heavy-ion collisions over a large range of impact parameters and nuclear species. Collisions with a center mass energy of 200 A GeV at RHIC are expected to produce the highest energy densities ever accessible in the laboratory. In this writeup, the authors outline the physics capabilities of the PHOBOS detector and describe the detector design in terms of the general philosophy behind the PHOBOS research program. In order to make the discussion concrete, they then focus on two specific examples of physics measurements that they plan to make at RHIC: $dN/d\eta$ for charged particles and the mass spectrum from $\phi \rightarrow K^+K^-$ decays.

30528 (UCRL-ID–121571, pp. Paper 5, 14 Pages) **The measurement of hadronic observables with the solenoidal tracker at RHIC (STAR).** Bellwied, R. (Wayne State Univ., Detroit, MI (United States)). Lawrence Berkeley Lab., CA (United States). 15 Jul 1995. (CONF-950198–: Physics with the collider detectors at Relavitistic Heavy Ion Collider (RHIC) and the LHC, Livermore, CA

(United States), 8 Jan 1995). In *Physics with the collider detectors at RHIC and the LHC.* 212p. Order Number DE95015976. Source: OSTI; NTIS; INIS; GPO Dep.

The authors describe the capabilities of the STAR detector at RHIC regarding the measurement of hadronic observables. Special emphasis will be given to the determination of event-by-event observables deduced from particle spectra for protons (p), kaons (K) and pions (π). The authors show that based on the present status of the simulations STAR will be able to measure quantities such as $<p_T>$, slope parameter, and particle ratios on an event-by-event basis. These parameters, in connection with charged particle multiplicities as a function of momentum and rapidity, may shed light on the occurance of a phase transition in ultrarelativistic heavy ion collisions.

30529 (UCRL-ID–121571, pp. Paper 7, 9 Pages) **Hard scattering of partons as a probe of collisions at RHIC using the STAR detector system.** Christie, W.B. (Brookhaven National Lab., Upton, NY (United States)). Lawrence Berkeley Lab., CA (United States). 15 Jul 1995. (CONF-950198–: Physics with the collider detectors at Relavitistic Heavy Ion Collider (RHIC) and the LHC, Livermore, CA (United States), 8 Jan 1995). In *Physics with the collider detectors at RHIC and the LHC.* 212p. Order Number DE95015976. Source: OSTI; NTIS; INIS; GPO Dep.

Presented here is the current state of the author's investigations into the use of hard probes to study pp, pA, and AA collisions at the Relativistic Heavy Ion Collider (RHIC) being built at Brookhaven National Laboratory. The overall goal of the RHIC program is the discovery and study of the Quark-Gluon Plasma (QGP), which is predicted to be formed at the high energy densities reached at RHIC in high energy AA collisions. The term "Hard probes" as used in this document includes those particles whose origin is the result of a direct hard parton scatter (i.e qq, qg, or gg). The final states of these hard parton scatters which the author proposes to study include dijets, gamma-jet coincidences, and inclusive high P_t particle spectra. A brief discussion of the physics objectives is given in section 1. This is followed by an introduction to the STAR detector system in section 2, with particular details given for the proposed STAR Electromagnetic Calorimeter (EMC). The present simulation studies and results are given in section 3. The author concludes with a summary and a discussion of future plans in section 4.

30530 (UCRL-ID–121571, pp. Paper 8, 10 Pages) **Strangeness detection in ALICE experiment at LHC.** Safarik, K. (European Lab. for Particle Physics, Geneva (Switzerland)). Lawrence Berkeley Lab., CA (United States). 15 Jul 1995. (CONF-950198–: Physics with the collider detectors at Relavitistic Heavy Ion Collider (RHIC) and the LHC, Livermore, CA (United States), 8 Jan 1995). In *Physics with the collider detectors at RHIC and the LHC.* 212p. Order Number DE95015976. Source: OSTI; NTIS; INIS; GPO Dep.

The authors present some parameters of the ALICE detector which concern the detection of strange particles. The results of a simulation for neutral strange particles and cascades, together with estimated rates are presented. They also briefly discuss the detection of charged K-mesons. Finally, they mention the possibility of open charm particle detection.

30531 (UCRL-ID–121571, pp. Paper 14, 8 Pages) **Photon physics with PHENIX.** White, S. (Brookhaven National Lab., Upton, NY (United States)). Lawrence Berkeley Lab., CA (United States). 15 Jul 1995. DOE Contract AC02-76CH00016. (CONF-950198–: Physics with the collider detectors at Relavitistic Heavy Ion Collider (RHIC) and the LHC, Livermore, CA (United States), 8 Jan 1995). In *Physics with the collider detectors at RHIC and the LHC.* 212p. Order Number DE95015976. Source: OSTI; NTIS; INIS; GPO Dep.

In this Paper the author discusses briefly the physics motivation for extending measurements of particle production with high granularity and particle id capabilities to neutrals in PHENIX. The author then discusses the technique of direct photon measurement in the presence of copious background photons from π^0 decays. The experiment will measure relatively low p_t photons near y=0 in the lab frame. This new experimental environment of high multiplicity and low γ momenta will affect both the techniques used and the type of analysis which can be performed. The Phenix Electromagnetic calorimeter is described and its capabilities illustrated with results from simulation and beam tests of the first production array.

30532 (UCRL-ID–121571, pp. Paper 17, 8 Pages) **Heavy ion physics at LHC with the Compact Muon Solenoid.** Bedjidian, M. (Universite Claude Bernard Lyon 1, Villeurbanne (France)); Contardo, D.; Haroutunian, R. Lawrence Berkeley Lab., CA (United States). 15 Jul 1995. (CONF-950198–: Physics with the collider detectors at Relavitistic Heavy Ion Collider (RHIC) and the LHC, Livermore, CA (United States), 8 Jan 1995). In *Physics with the collider detectors at RHIC and the LHC.* 212p. Order Number DE95015976. Source: OSTI; NTIS; INIS; GPO Dep.

The Compact Muon Solenoid (CMS), is one of the two detectors proposed to achieve the primary goal of the LHC: the discovery of the Higgs boson(s). For this purpose, the detector is optimized for the precise measurement of muons, photons, electrons and jets. It is a clear motivation to investigate its ability to measure the hard processes probing the formation of a Quark Gluon Plasma (QGP) in ion collisions. It is the case of the heavy quark bound states, long predicted to be suppressed in a QGP. In CMS they can be detected, via their muonic decay according to the principle adopted for the p-p physics.

30533 (UCRL-ID–121571, pp. Paper 18, 10 Pages) **The ALICE Inner Tracking System: Design, physics performance and R&D issues.** Giubellino, P. (IXFN, Torino (Italy)). Lawrence Berkeley Lab., CA (United States). 15 Jul 1995. (CONF-950198–: Physics with the collider detectors at Relavitistic Heavy Ion Collider (RHIC) and the LHC, Livermore, CA (United States), 8 Jan 1995). In *Physics with the collider detectors at RHIC and the LHC.* 212p. Order Number DE95015976. Source: OSTI; NTIS; INIS; GPO Dep.

ALICE is a dedicated Heavy-Ion experiment proposed for the future LHC collider at CERN. The main goals of the ALICE Inner Tracking System are the reconstruction of secondary vertexes and the tracking and identification of low-p_t electrons; at the same time, it will provide a significant improvement of the momentum resolution at large p_t and the tracking and identification of low-p_t hadrons. The ITS will consist of five cilindrical layers of radii from 7.5 to 50 cm. of high-resolution detectors. The unprecedented particle density foreseen, of up to 8000 particles per unit η, imposes the use of sophisticated, and often innovative, technologies for the detectors, the electronics and the support and cooling system. Therefore, extensive R&D programs are now being pursued on various aspects of the project. Here are presented the basic ideas for the design, a few examples of the expected performance, and a brief overview of the ongoing R&D.

30534 (UCRL-ID–121571, pp. Paper 19, 12 Pages) **Particle identification using time-of-flight technology for the ALICE experiment.** Schmidt, H.R. Lawrence Berkeley Lab., CA (United States). 15 Jul 1995. (CONF-950198–: Physics with the collider detectors at Relavitistic Heavy Ion Collider (RHIC) and the LHC, Livermore, CA (United States), 8 Jan 1995). In *Physics with the collider detectors at RHIC and the LHC.* 212p. Order Number DE95015976. Source: OSTI; NTIS; INIS; GPO Dep.

The large multiplicities expected for LHC Pb+Pb collisions require new development in particle identification techniques. Presently, Pestov Spark Counters, low pressure Parallel Plate Chambers and scintillators with photo multiplier readout are under consideration.

30535 (UCRL-JC–118903) **Survey of portable radiological instrumentation at 16 DOE sites.** Coutts, G.W.; Hickman, D. Lawrence Livermore National Lab., CA (United States). 1 Jun 1995. 22p. Sponsored by USDOE, Washington, DC (United States). DOE Contract W-7405-ENG-48. (CONF-951073–7: IEEE nuclear science symposium and medical imaging conference, San Francisco, CA (United States), 21-28 Oct 1995). Order Number DE96000364. Source: OSTI; NTIS; GPO Dep.

The DOE-DP complex initiated a Radiological Instrument Standardization and Qualification Program to ensure the quality of radiological measurements within each DOE site. As part of the program, a complex-wide survey was conducted of all portable instruments in use at 16 DOE facilities. This paper presents the data gathered and suggests several possible standardization options.

30536 (UM-P--94/91) **Observation of X-ray intensity distribution from the anode of a fine-focus tube using $\Delta\omega$ - $\Delta 2\theta$ scans.** Grigg, M.W. (Melbourne Univ., Parkville, VIC (Australia). School of Physics); Barnea, Z.; Maslen, V.W. Melbourne Univ., Parkville, VIC (Australia). School of Physics. [1995]. 5p. Sponsored by Australian Research Council, Canberra, ACT (Australia). Order Number DE96602745. Source: OSTI; NTIS; INIS.

A split intensity distribution from the anode of fine focus x-ray tubes probably due to tungsten deposited on the target is reported. Such a doubling of the target complicates the interpretation of $\Delta\omega$ -$\Delta 2\theta$ intensity distributions and introduces systematic errors in the determination of lattice parameters. It is estimated that the increasing tungsten deposit affects, in time, the intensity of x-ray tubes. 4 refs., 4 figs.

4402 Radiation Effects On Instrument Components, Instruments, Or Electronic Systems

Refer also to citation(s) 30482

30537 (SAND--95-1935C) **Fast and slow border traps in MOS devices.** Fleetwood, D.M.; Warren, W.L.; Schwank, J.R.; Winokur, P.S.; Shaneyfelt, M.R.; Riewe, L.C. Sandia National Labs., Albuquerque, NM (United States). [1995]. 3p. Sponsored by USDOE, Washington, DC (United States);Defense Nuclear Agency, Washington, DC (United States). DOE Contract AC04-94AL85000. (CONF-951247--1: IEEE semiconductor interface specialists conference, Charleston, SC (United States), 7-9 Dec 1995). Order Number DE95017550. Source: OSTI; NTIS; GPO Dep.

In this paper we apply a "dual-transistor border-trap" (DTBT) technique that combines high-frequency charge-pumping and lower-frequency threshold-voltage measurements to estimate bulk-oxide-trap, interface-trap, and border-trap densities in irradiated MOS transistors. This method takes advantage of the different time scales in which interface traps and border traps exchange charge with the Si to obtain an estimate of the density of faster border traps often mistaken for interface traps. Effects of slower border traps are also inferred from changes in the "bulk" oxide-trap charge density through switched-bias annealing. To our knowledge, this is the first time fast and slow border-trap effects have been separated quantitatively in MOS devices. Possible microstructures for fast and slow border traps are suggested.

4405 Thermal Instrumentation

Refer also to citation(s) 31184

4406 Optical Instrumentation

Refer also to citation(s) 29848, 29984, 30237, 30369, 30561, 31264

30538 (ANL/APS/TB--24) **Diamond monochromators for APS undulator-A beamlines.** Blasdell, R.C.; Assoufid, L.A.; Mills, D.M. Argonne National Lab., IL (United States). Sep 1995. 60p. Sponsored by USDOE, Washington, DC (United States). DOE Contract W-31109-ENG-38. Order Number DE96000979. Source: OSTI; NTIS; INIS; GPO Dep.

There has been considerable interest in the use of diamonds in high heat load monochromators (HHLMs) in the last several years. The superb thermal and mechanical properties of single crystal diamonds serve to minimize distortions caused by a given thermal load, while the low x-ray absorption cross-section reduces both the total power deposited in the crystal as well as the peak (volumetric) power density. The primary obstacle for the widespread use of diamonds at present is a lack of ready availability of perfect single crystals of the desired size and orientation. Although it is possible to obtain near-perfect natural diamonds of the size and orientation required for use on an undulator beamline, the selection process is generally one of trial and error. Near perfect synthetic diamonds can currently be obtained in the minimum necessary size (typically 4-5 mm on a side). A collaborative agreement has been made between the staff of the Advanced Photon Source (APS), the European Synchrotron Radiation Facility (ESRF), and the Super Photon Ring-8 GeV (SPring-8) to explore the use of diamonds as high heat load monochromators and is on-going. One of the avenues of research is to push for improved perfection and size of synthetic diamonds. Sumitomo Electric Corporation of Japan has agreed to work with staff from SPring-8 to grow [100] oriented perfect single crystal diamonds of 10 x 10 x 1 mm^3 size by 1996/1997 (from which one could also cut pieces with the large face parallel to the (111) planes). They have taken the first step in producing an essentially perfect 4 x 4 x 1 mm^3 type II diamond with less than 5 μrad (1 arc second) strain (measured over the entire surface). The authors believe progress in the production of synthetic diamonds, as well as improvement in ties with suppliers of natural diamonds, should make available a relatively large number of high quality diamonds of moderate size within the next several years.

30539 (CONF-950793--33) **Hybrid optics for the visible produced by bulk casting of sol-gel glass using diamond-turned molds.** Bernacki, B.E. (Oak Ridge National Lab., TN (United States)); Miller, A.C.; Maxey, L.C.; Cunningham, J.P.; Moreshead, W.V.; Nogues, J.L.R. Oak Ridge National Lab., TN (United States). [1995]. 12p. Sponsored by USDOE, Washington, DC (United States);Department of the Army, Washington, DC (United States). DOE Contract AC05-84OR21400. Contract DAAH04-94-C-0061. From 40. annual meeting of the Society of Photo-Optical Instrumentation Engineers; San Diego, CA (United States); 9-14 Jul 1995. Order Number DE95014046. Source: OSTI; NTIS; GPO Dep.

Recent combinations of diffractive and refractive functions in the same optical component allow designers additional opportunities to make systems more compact and enhance performance. This paper describes a research program for fabricating hybrid refractive/diffractive components from diamond-turned molds using the bulk casting of sol-gel silica glass. The authors use the complementary dispersive nature of refractive and diffractive optics to render two-color correction in a single hybrid optical element. Since diamond turning has matured as a deterministic manufacturing technology, techniques previously suitable only in the infrared are now being applied to components used at visible wavelengths. Thus, the marriage of diamond turning and sol-gel processes offers a cost-effective method for producing highly customized and specialized optical components in high quality silica glass. With the sol-gel casting method of replication, diamond-turned mold costs can be shared over many pieces. Diamond turning takes advantage of all of the available degrees of freedom in a single hybrid optical element: aspheric surface to eliminate spherical aberration, kinoform surface for control of primary chromatic aberration, and the flexibility to place the kinoform on non-planar surfaces for maximum design flexibility. The authors discuss the critical issues involved in designing the hybrid element, single point diamond-turning the mold, and fabrication in glass using the sol-gel process.

30540 (ETDE/CH-mf--95787322, pp. 80-82) **Calibration of an optical crosswind anemometer.** Poggio, L. (Atmosphaerenphysik ETH, Zurich (Switzerland)); Furger, M.; Graber, W.K.; Rohde, M. Paul Scherrer Inst. (PSI), Villigen (Switzerland). 1995. In *Paul Scherrer Institut annual report 1994. Annex V: PSI general energy technology newsletter 1994*. 123p. Source: OSTI; NTIS.

The testing and calibration of a scintillation anemometer are documented in this report. The instrument determines the wind velocity across a light beam. The measurements proved to be reliable and the scintillometer will be useful in determining wind components perpendicular to a light path of 1 km length. (author) 3 figs., 2 tabs., 4 refs.

30541 (KRC--89A-J03) **A Study on the Development and Application of Monitoring System for Power Transmission Facilities by using the Optical Sensors.** Lee, K.J. (Korea Electric Power Corp. (KEPCO), Taejon (Korea, Republic of). Research Center); Cho, H.K.; Han, M.S.; Kim, S.K.; Oh, M.T; Park, K.J.; Kim, W.K.; Park, H.K.; Kim, N.; Ban, J.K.; Song, W.Y.; Park, S.K.; Lee, S.Y.; Lee, K.Y.; Lee, Y.H.; Yoon, J.Korea Electric Power Corp. (KEPCO), Taejon (Korea, Republic of). Research Center. 1993. 239p. (In Korean). Order Number DE96703559. Source: OSTI; NTIS (US Sales Only).

Corresponding to extended scope of transmission line maintenance and surveillance system, complex and long transmission line, high capacity and diversutt of monitoring information owing to

bulky and high voltage of the system, there have been great demands for new measurement and communication technology on maintenance and monitoring of transmission line facilities. Henceforth in the field of large scale communication system, to overcome shortcomings that former electrical communication has, the introduction of optical communication system is actively being carried out and especially for transmission of power information such as protection, monitoring and control of electric power system operation, optical fiber composite overhead ground wire(OPGW) is increasingly built in the field. Accordingly, from formerly installed optical fibers in OPGW, by utilizing fiber's low loss, wide bandwidth, high dielectric properties, system information for maintenance, i.e. fault information, weather information, etc. are directly sent to the maintenance department. This promotion in modernization of power transmission line maintenance will set up basis for the realization of effective management, automatic control and remote sensing in maintenance tasks. Eventually, this system can provides various information such as wind velocity and direction, state of aircraft warning lamp and fault current information ground wire etc.. (author). 38 refs., figs.

30542 (KRC–89A-J10) **Development and Application of Optical CT, PT.** Shin, K.H. (Korea Electric Power Corp. (KEPCO), Taejon (Korea, Republic of). Research Center); Woo, H.K.; Lee, K.J.; Cho, H.K.; Kim, S.K.; Choi, G.M.; Kim, Y.H.; Kim, K.H.; Oh, S.K.; Kim, Y.S.; Kim, I.S.; Song, J.S.; Park, H.S.; Oh, W.R.; Choi, H.H.; Yoo,.Korea Electric Power Corp. (KEPCO), Taejon (Korea, Republic of). Research Center. 1993. 209p. (In Korean). Order Number DE96703568. Source: OSTI; NTIS (US Sales Only).

To operate electric power systems economically and stably, measurement of the current and voltage is essential. Since existing current transformer(CT) and potential transformer(PT) are composed by iron core and coil, those are vulnerable from electromagnetic interference(EMI), harmonics and saturation etc.. Furthermore, the transmission of the transmission voltage hierachy has become bulky, e.g. 765kv, optical CT/PT is regarded as a solution of the cost effective and reliable instrumentation. To meet those needs we developed an optical CT/PT for the distribution line and CT for the transmission line(154kv). BSO cristal sensors are adopted for the detecting optical rotation to convert the current and voltage. Developed optical CT/PT are installed on the 22.9kv and 154kv line that are in Sam-Jeong substation suburb Chang-Won city. The result of field trial ascertains the practical use of the technology. (author). 25 refs., figs.

30543 (KRC–92A-J02) **Research on the fault section detecting system for underground transmission lines using optical technologies.** Lee, K.J. (Korea Electric Power Corp. (KEPCO), Taejon (Korea, Republic of). Research Center); Lee, B.K.; Cho, H.K.; Kim, S.K.; Oh, M.T.; Choi, J.H.; Yoon, H.H.; Kim, Y.H.; Kim, K.H.; Kim, Y.S.; Lee, W.T.; Park, H.S.; Kim, E.H.; Lee, J.J.; No, J.D. Korea Electric Power Corp. (KEPCO), Taejon (Korea, Republic of). Research Center. 1994. 214p. (In Korean). Order Number DE96703563. Source: OSTI; NTIS (US Sales Only).

Automation in the electric power systems and underground transmission system are rapidly adopted in a big city. But there is no monitoring system which can detect the fault section or fault location in the underground power transmission lines. In this case, if there is fault caused by shorted lines, it may give rise to following problems. - The difficulty of maintenance - It takes a long time to detect the fault and repair it - The faults will give the serious problems to the whole system. Recently, the fiber optic voltage sensors and the fiber optic current sensors have been developed and now are being tested for practical use. And also research and development of the optical communication of the optical communication systems and the relational technologies are actively progressed. It is necessary to develop the total monitoring system and fault section detecting system which are used for preventing from not a few kinds of faults in underground power transmission system. This research aims for developing the Algorithm of fault section detecting system using optical sensing technique, and drawing up the construction scheme of surveillance system for 345KV underground power transmission lines. (author). 22 refs., figs.

30544 (KRC–92A-J03) **A study on the up-grade of optic instrument and control system in power plant.** Nam, K.C. (Korea Electric Power Corp. (KEPCO), Taejon (Korea, Republic of). Research Center); Lee, B.K.; Cho, H.G.; Oh, M.T.; Kim, S.K.; Yoon, M.W.; Cho, W.S.; Lee, W.H.; Kim, K.D.; Kye, K.H.; Yang, G.H.; Song, W.S.; Kim, S.H.; Park, J.B.; Lee, J.M.; Kim,.Korea Electric Power Corp. (KEPCO), Taejon (Korea, Republic of). Research Center. 1994. 243p. (In Korean). Order Number DE96703564. Source: OSTI; NTIS (US Sales Only).

In this study, we developed a SOE(Sequence Of Event) back-up system and a fiber optic temperature measuring system. SOE back-up system is developed to back-up the SOE system which is essential to analyze troubles in power plants. And fiber optic temperature measuring system measures the temperature of coal powder in feeder lines which are connected to boiler. By temperature information, the status of coal feeder lines and boiler operation can be supervised. (author). 12 refs., figs.

30545 (LA-UR–95-273) **Flare star observations with a single-photon counting imaging detector.** Casperson, D.E.; Priedhorsky, W.C.; Baron, M.H.; Ho, C. Los Alamos National Lab., NM (United States). [1995]. 6p. Sponsored by USDOE, Washington, DC (United States). DOE Contract W-7405-ENG-36. (CONF-951217–1: IAU colloquium, Sonneberg (Germany), 5-9 Dec 1995). Order Number DE95006266. Source: OSTI; NTIS; GPO Dep.

At Los Alamos National Laboratory we are developing a new imaging sensor which combines high spatial and high temporal resolution over a large area format, while maintaining single-photon counting sensitivity and substaining a high count rate. The detector is called a microchannel plate with crossed delay line readout, or MCP/CDL. This detector is ideally suited to the observation of weak transient events, such as stellar flares from red dwarf flare stars in our Galaxy. At present we are initiating an experiment with the MCP/CDL detector which will utilize a 30-cm aperture f/7 telescope to characterize U-band, B-band, and U-band emission from such low- luminosity flare stars, and to search for weak optical transients associated with other astrophysical sources.

30546 (LA-UR–95-2407) **Image enhancement using a range gated MCPII video system with a 180-ps FWHM shutter.** Thomas, M.C. (Special Technologies Laboratory, Santa Barbara, CA (United States)); Yates, G.J.; Zadgarino, P. Los Alamos National Lab., NM (United States). [1995]. 10p. Sponsored by USDOE, Washington, DC (United States). DOE Contract W-7405-ENG-36 ; AC08-93NV11265. (CONF-950793–17: 40. annual meeting of the Society of Photo-Optical Instrumentation Engineers, San Diego, CA (United States), 9-14 Jul 1995). Order Number DE95016891. Source: OSTI; NTIS; GPO Dep.

The video image of a target submerged in a scattering medium was improved through the use of range gating techniques. The target, an Air Force resolution chart, was submerged in 18 in. of a colloidal suspension of tincture green soap in water. The target was illuminated with pulsed light from a Raman shifted, frequency-doubled, ND:YAG laser having a wavelength of 559 mm and a width of 20 ps FWHM. The laser light reflected by the target along with the light scattered by the soap, was imaged onto a microchannel-plate image intensifier (MCPII). The output from the MCPII was then recorded with a RS-170 video camera and a video digitizer. The MCPII was gated on with a pulse synchronously timed to the laser pulse. The relative timing between the reflected laser pulse and the shuttering of the MCPII determined the distance to the imaged region. The resolution of the image was influenced by the MCPII's shutter time. A comparison was made between the resolution of images obtained with 6 ns, 500 ps and 180 ps FWHM (8 ns, 750 ps and 250 ps off-to-off) shutter times. it was found that the image resolution was enhanced by using the faster shutter since the longer exposures allowed light scattered by the water to be recorded too. The presence of scattered light in the image increased the noise, thereby reducing the contrast and the resolution.

30547 (LBL–37536) **The role of lanthanides in optical materials.** Weber, M.J. Lawrence Berkeley Lab., CA (United States). May 1995. 18p. Sponsored by USDOE, Washington, DC (United States);Public Health Service, Washington, DC (United States). DOE Contract AC03-76SF00098. Grant R01 CA48002. (CONF-9505249–13: 97. American Ceramic Society (ACS) annual meeting

and exposition, Cincinnati, OH (United States), 2 May 1995). Order Number DE96001114. Source: OSTI; NTIS; GPO Dep.

A survey is presented of the use of the lanthanides as chemical components in transmitting optical materials and as activators in materials for luminescent, electro-optic, magneto-optic, and various photosensitive applications.

30548 (SAND–95-1671C) **A two dimensional array of optical interference filters produced by lithographic alterations of the index of refraction.** Kaushik, S.; Stallard, B.R. Sandia National Labs., Albuquerque, NM (United States). [1995]. 7p. Sponsored by USDOE, Washington, DC (United States). DOE Contract AC04-94AL85000. (CONF-950793–28: 40. annual meeting of the Society of Photo-Optical Instrumentation Engineers, San Diego, CA (United States), 9-14 Jul 1995). Order Number DE95016090. Source: OSTI; NTIS; GPO Dep.

We describe a new concept for producing, on a single substrate, a two-dimensional array of optical interference filters where the pass-band of each element can be independently specified. The interference filter is formed by optically contacting two dielectric mirrors so that the top quarter-wave films of the two mirrors form a Fabry-Perot cavity having a half-wave thickness. In the new device, we propose to etch an array of sub-wavelength patterns into the top surface of one of the mirrors before forming the cavity. The patterns must have a pitch shorter than the operational wavelength in order to eliminate diffraction. By changing the index of refraction of the half-wave layer, or the optical thickness of the cavity, the patterning is used to shift the pass-band and form an array of interference filters. One approach to producing the array is to change the fill factor of the pattern. Once the filter array is produced it may be mated to a two-dimensional detector array to form a miniature spectrophotometer.

30549 (SAND–95-1775) **LDRD Project progress report: Broadly tunable, solid-state coherent light sources.** Smith, A.V.; Alford, W.J.; Raymond, T.D. Sandia National Labs., Albuquerque, NM (United States). Aug 1995. 70p. Sponsored by USDOE, Washington, DC (United States). DOE Contract AC04-94AL85000. Order Number DE95017633. Source: OSTI; NTIS; GPO Dep.

Our program of nanosecond optical parametric oscillator (OPO) development has concentrated on improving the spectral purity and tunability as well as the beam quality of OPO's and other tunable sources based on frequency mixing in nonlinear crystals. To facilitate quick evaluation of new OPO and frequency-mixing configurations and to provide insight to OPO operation, we developed a computer model of seeded OPO operation that includes pump depletion, birefringent walkoff, diffraction, temporal and spatial beam profiles, and cavity optics. It predicts conversion efficiency, beam quality, spectra, and time behavior. Our model development was complemented by laboratory OPO studies that served to validate the model and also to highlight the practical problems associated with limitations of optical coating and nonlinear crystal growth technologies. We present here a set of papers that compare model calculation and laboratory characterization of a seeded, nanosecond OPO, that apply the model to illustrate distortions of specta and beam quality in frequency mixing, and that point out the peculiarities of two-crystal frequency mixing.

30550 (SAND–95-1884C) **Analysis of a high intensity x-ray source using a specialized Doppler interferometer system.** Fleming, K.J. Sandia National Labs., Albuquerque, NM (United States). [1995]. 4p. Sponsored by USDOE, Washington, DC (United States). DOE Contract AC04-94AL85000. (CONF-950846–12: American Physical Society biennial conference on shock compression of condensed matter, Seattle, WA (United States), 13-18 Aug 1995). Order Number DE95016755. Source: OSTI; NTIS; GPO Dep.

The Saturn accelerator at Sandia National Laboratories is a high power, variable-spectrum, x-ray source capable of simulating radiation effects of nuclear countermeasures on electronic and material components of space systems. It can also function as a pulsed-power and radiation source, and as a diagnostic test bed for a variety of applications. Obtaining highly accurate measurements of the emission spectra is difficult because the high intensity x-rays and MegaAmpere levels of current inside the experiment chamber can damage or destroy electronic measurement devices. For these reasons, an optical based measurement system has been designed, developed and successfully tested in the Saturn accelerator. The system uses fiber optic coupled sensor(s) connected to a specialized Doppler interferometer system which analyzes the shock wave imparted into a target material. This paper describes the optical system, its related components, and material response data of polymethyl methacrylate.

30551 (UCRL-CR–119157) **Processing of polarametric SAR images. Final report.** Warrick, A.L. (Univ. of Arizona, Tucson, AZ (United States)); Delaney, P.A. Lawrence Livermore National Lab., CA (United States). [1995]. 15p. Sponsored by USDOE, Washington, DC (United States). DOE Contract W-7405-ENG-48. Order Number DE95017256. Source: OSTI; NTIS; GPO Dep.

The objective of this work was to develop a systematic method of combining multifrequency polarized SAR images. It is shown that the traditional methods of correlation, hard targets, and template matching fail to produce acceptable results. Hence, a new algorithm was developed and tested. The new approach combines the three traditional methods and an interpolation method. An example is shown that demonstrates the new algorithms performance. The results are summarized suggestions for future research are presented.

30552 (UCRL-ID–120801) **Statement of capabilities: Micropower Impulse Radar (MIR) technology applied to mine detection and imaging.** Azevedo, S.G.; Gavel, D.T.; Mast, J.E.; Warhus, J.P. Lawrence Livermore National Lab., CA (United States). 13 Mar 1995. 14p. Sponsored by USDOE, Washington, DC (United States). DOE Contract W-7405-ENG-48. Order Number DE95017714. Source: OSTI; NTIS; GPO Dep.

The Lawrence Livermore National Laboratory (LLNL) has developed radar and imaging technologies with potential applications in mine detection by the armed forces and other agencies involved in demining efforts. These new technologies use a patented ultra-wideband (impulse) radar technology that is compact, low-cost, and low power. Designated as Micropower Impulse Radar, these compact, self-contained radars can easily be assembled into arrays to form complete ground penetrating radar imaging systems. LLNL has also developed tomographic reconstruction and signal processing software capable of producing high-resolution 2-D and 3-D images of objects buried in materials like soil or concrete from radar data. Preliminary test results have shown that a radar imaging system using these technologies has the ability to image both metallic and plastic land mine surrogate targets buried in 5 to 10 cm of moist soil. In dry soil, the system can detect buried objects to a depth of 30 cm and more. This report describes LLNL's unique capabilities and technologies that can be applied to the demining problem.

30553 (UCRL-ID–121832) **LDRD 93-ERP-166 Final report.** Bennett, C.L.; Carter, M.R.; Fields, D.J.; Lee, F.D. Lawrence Livermore National Lab., CA (United States). Jul 1995. 15p. Sponsored by USDOE, Washington, DC (United States). DOE Contract W-7405-ENG-48. Order Number DE96000752. Source: OSTI; NTIS; GPO Dep.

In this article, recent measurements made with LIFTIRS, the Livermore Imaging Fourier Transform Infrared Spectrometer, are presented. The experience gained with this instrument has produced a variety of insights into the tradeoffs-between signal to noise ratio (SNR), spectral resolution and temporal resolution for time multiplexed Fourier transform imaging spectrometers. This experience has also clarified the practical advantages and disadvantages of Fourier transform hyperspectral imaging spectrometers regarding adaptation to varying measurement requirements on SNR vs spectral resolution, spatial resolution and temporal resolution.

30554 (UCRL-JC–120550) **An impulse radar array for detecting land mines.** Gavel, D.T.; Mast, J.E.; Warhus, J.; Azevedo, S.G. Lawrence Livermore National Lab., CA (United States). 3 Apr 1995. 12p. Sponsored by USDOE, Washington, DC (United States). DOE Contract W-7405-ENG-48. (CONF-9504154–3: Symposium on autonomous vehicles in mine countermeasures, Monterey, CA (United States), 3-7 Apr 1995). Order Number DE95017847. Source: OSTI; NTIS; GPO Dep.

The Lawrence Livermore National Laboratory has developed radar and imaging technologies with potential application in demining efforts. A patented wideband (impulse) radar that is very compact, very low cost, and very low power, has been demonstrated in test fields to be able to detect and image nonmetallic land mines buried in 2-10 cm of soil. The scheme takes advantage of the very short radar impulses and the ability to form a large synthetic aperture with many small individual units, to generate high resolution 2-D or 3-D tomographic images of the mine and surrounding ground. Radar range calculations predict that a vehicle-mounted or man-carried system is quite feasible using this technology. This paper presents the results of field tests using a prototype unit and describes practical mine detection system concepts. Predicted capabilities in terms of stand-off range and radiated power requirements are discussed.

30555 (UCRL-JC–121520) **White light velocity interferometry.** Erskine, D.J. Lawrence Livermore National Lab., CA (United States). Aug 1995. 3p. Sponsored by USDOE, Washington, DC (United States). DOE Contract W-7405-ENG-48. (CONF-950846–56: American Physical Society biennial conference on shock compression of condensed matter, Seattle, WA (United States), 13-18 Aug 1995). Order Number DE95017068. Source: OSTI; NTIS; GPO Dep.

We describe a generic method for using broadband and incoherent light in velocity interferometry. Single frequency lasers are no longer necessary. Compact, powerful and inexpensive light sources previously prohibited due to their incoherence are now suitable for Doppler velocimetry of remote objects through air, including arc lamps, flash lamps, light from detonations, pulsed lasers, chirped frequency lasers and lasers operated simultaneously in several lines. These powerful sources should allow practical line and areal velocimetry. In our technique, the light source is imprinted with a coherent echo having a delay matching the delay in an analyzing interferometer. The technique is generic to all wave phenomena (i.e. radar, ultrasound).

30556 (UCRL-JC–121622) **Ultra high resolution soft x-ray tomography.** Haddad, W.S. (and others); Trebes, J.E.; Goodman, D.M. Lawrence Livermore National Lab., CA (United States). 19 Jul 1995. 8p. Sponsored by USDOE, Washington, DC (United States). DOE Contract W-7405-ENG-48. (CONF-950793–45: 40. annual meeting of the Society of Photo-Optical Instrumentation Engineers, San Diego, CA (United States), 9-14 Jul 1995). Order Number DE95017871. Source: OSTI; NTIS; INIS; GPO Dep.

Ultra high resolution three dimensional images of a microscopic test object were made with soft x-rays using a scanning transmission x-ray microscope. The test object consisted of two different patterns of gold bars on silicon nitride windows that were separated by ~5μm. A series of nine 2-D images of the object were recorded at angles between −50 to +55 degrees with respect to the beam axis. The projections were then combined tomographically to form a 3-D image by means of an algebraic reconstruction technique (ART) algorithm. A transverse resolution of ~1000 Å was observed. Artifacts in the reconstruction limited the overall depth resolution to ~6000 Å, however some features were clearly reconstructed with a depth resolution of ~1000 Å. A specially modified ART algorithm and a constrained conjugate gradient (CCG) code were also developed as improvements over the standard ART algorithm. Both of these methods made significant improvements in the overall depth resolution bringing it down to ~1200 Å overall. Preliminary projection data sets were also recorded with both dry and re-hydrated human sperm cells over a similar angular range.

4407 Geophysical and Meteorological Instrumentation

Refer also to citation(s) 30641, 30651

30557 (KFK–5438) **The airborne remote sensing experiment MIPAS-FT: data analysis and interpretation of the artic campaigns 1991/92 and 1992/93.** Hoepfner, M. Kernforschungszentrum Karlsruhe GmbH (Germany). Inst. fuer Meteorologie und Klimaforschung; Karlsruhe Univ. (T.H.) (Germany). Fakultaet fuer Physik. Dec 1994. 192p. (In German). Order Number DE96706559. Source: OSTI; NTIS (US Sales Only).

This thesis deals with the data evaluation process and the interpretation of measurements performed in arctic and mid-latitudes by the airborne Michelson-Interferometer for Passive Atmospheric Sounding - Flugzeug Transall (MIPAS-FT) during the winter seasons 1991/92 and 1992/93. Sounding upward on a slant path through the atmosphere, the high-resolution spectrometer analyses the infrared radiation emitted by the trace constitutents. The aim of this work was to deduce column amounts of trace gases from these measurements and to interpret their spatial structure and their temporal development with regard to their importance to the chemistry of stratospheric ozone reduction. (orig./KW)

30558 (SAND–95-0264C) **Time efficient 3-D electromagnetic modeling on massively parallel computers.** Alumbaugh, D.L.; Newman, G.A. Sandia National Labs., Albuquerque, NM (United States). [1995]. 14p. Sponsored by USDOE, Washington, DC (United States). DOE Contract AC04-94AL85000. (CONF-9510199–1: Symposium on three-dimensional electromagnetics, Ridgefield, CT (United States), 4-6 Oct 1995). Order Number DE95016085. Source: OSTI; NTIS; GPO Dep.

A numerical modeling algorithm has been developed to simulate the electromagnetic response of a three dimensional earth to a dipole source for frequencies ranging from 100 to 100MHz. The numerical problem is formulated in terms of a frequency domain–modified vector Helmholtz equation for the scattered electric fields. The resulting differential equation is approximated using a staggered finite difference grid which results in a linear system of equations for which the matrix is sparse and complex symmetric. The system of equations is solved using a preconditioned quasi-minimum-residual method. Dirichlet boundary conditions are employed at the edges of the mesh by setting the tangential electric fields equal to zero. At frequencies less than 1MHz, normal grid stretching is employed to mitigate unwanted reflections off the grid boundaries. For frequencies greater than this, absorbing boundary conditions must be employed by making the stretching parameters of the modified vector Helmholtz equation complex which introduces loss at the boundaries. To allow for faster calculation of realistic models, the original serial version of the code has been modified to run on a massively parallel architecture. This modification involves three distinct tasks; (1) mapping the finite difference stencil to a processor stencil which allows for the necessary information to be exchanged between processors that contain adjacent nodes in the model, (2) determining the most efficient method to input the model which is accomplished by dividing the input into "global" and "local" data and then reading the two sets in differently, and (3) deciding how to output the data which is an inherently nonparallel process.

30559 (UCRL-ID–121566-Pt.1) **Clementine Star Tracker Stellar Compass: Final report part 1.** Priest, R.E. (and others); Kordas, J.F.; Lewis, I.T. Lawrence Livermore National Lab., CA (United States). Jul 1995. 700p. Sponsored by USDOE, Washington, DC (United States). DOE Contract W-7405-ENG-48. Order Number DE96001143. Source: OSTI; NTIS; GPO Dep.

The Clementine mission provided the first ever complete, systematic surface mapping of the moon from the ultra-violet to the near-infrared regions. More than 1.7 million images of the moon, earth and space were returned from this mission. Two star stracker stellar compasses (star tracker camera + stellar compass software) were included on the spacecraft, serving a primary function of providing angle updates to the guidance and navigation system. These cameras served a secondary function by providing a wide field of view imaging capability for lunar horizon glow and other dark-side imaging data. This 290 g camera using a 576 x 384 focal plane array and a 17 mm entrance pupil, detected and centroided stars as dim and dimmer than 4.5 m_v, providing rms pointing accuracy of better than 100 μrad pitch and yaw and 450 μrad roll. A description of this light-weight, low power star tracker camera along with a summary of lessons learned is presented. Design goals and preliminary on-orbit performance estimates are addressed in terms of meeting the mission's primary objective for flight qualifying the sensors for future Department of Defense flights. Documentation

generated during the design, analysis, build, test and characterization of the star tracker cameras are presented. Collectively, this documentation represents a small library of information for this camera, and may be used as a framework for producing copy units by commercial enterprises, and therefore satisfies a Department of Defense and Department of Energy goal to transfer technology to industry. However, the considerable knowledge gained from the experience of the individuals involved in the system trades, design, analysis, production, testing and characterization of the star tracker stellar compass is not contained in this documentation.

30560 (UCRL-ID–121566-Pt.2) **Clementine Star Tracker Stellar Compass: Final report part 2.** Priest, R.E. (and others); Kordas, J.F.; Lewis, I.T. Lawrence Livermore National Lab., CA (United States). Jul 1995. 600p. Sponsored by USDOE, Washington, DC (United States). DOE Contract W-7405-ENG-48. Order Number DE96001144. Source: OSTI; NTIS; GPO Dep.

This document describes the assembly procedures for the Clementine Star Tracker Camera.

4408 Miscellaneous Instrumentation

Refer also to citation(s) 30080, 30299, 30378, 30453, 30476, 30575, 30577, 30580, 30587, 30713, 30758, 31128, 31152

30561 (BNL–61989) **A novel ellipsometer design for the study of large thin films.** Lin, Y.; Premuzic, E.; Lin, M. Brookhaven National Lab., Upton, NY (United States). Jul 1995. 10p. Sponsored by USDOE, Washington, DC (United States). DOE Contract AC02-76CH00016. (CONF-950793–16: 40. annual meeting of the Society of Photo-Optical Instrumentation Engineers, San Diego, CA (United States), 9-14 Jul 1995). Order Number DE95016020. Source: OSTI; NTIS; GPO Dep.

This paper describes a novel long-scanning reflection ellipsometer to characterize large thin films. The ellipsometer uses a frequency stabilized Zeeman-split He-Ne laser as the source. Two common-path left and right circularly polarized beams, with a slight frequency difference, work as the incident beams. Beat frequency signals are detected from the reflected beams on a sample, and the thin film properties are studied. An optical common-mode rejection technique is employed to minimize the effects of environmental conditions. Measurements are not sensitive to low frequency noise and ignore any electronic dc offset effects. The variations of the beam intensities of the source do not affect the experimental results. The optical system is designed to be arranged on a long air-bearing slide with an autofocus system of 0.1 μm resolution in the range of 25 mm. Measurements will covert the range from 3 μm to 600 mm. Experimental results can be taken in the ordinary experimental conditions.

30562 (DOE/ER/61029–19) **A system for aerodynamically sizing ultrafine environmental radioactive particles.** Olawoyin, L. Clarkson Univ., Potsdam, NY (United States). Dept. of Chemical Engineering. Sep 1995. 104p. Sponsored by USDOE, Washington, DC (United States). DOE Contract FG02-90ER61029. Order Number DE95017100. Source: OSTI; NTIS; INIS; GPO Dep.

The unattached environmental radioactive particles/clusters, produced mainly by ^{222}Rn in indoor air, are usually few nanometers in size. The inhalation of these radioactive clusters can lead to deposition of radioactivity on the mucosal surface of the tracheobronchial tree. The ultimate size of the cluster together with the flow characteristics will determine the depositional site in the human lung and thus, the extent of damage that can be caused. Thus, there exists the need for the determination of the size of the radioactive clusters. However, the existing particle measuring device have low resolution in the sub-nanometer range. In this research, a system for the alternative detection and measurement of the size of particles/cluster in the less than 2 nm range have been developed. The system is a one stage impactor which has a solid state spectrometer as its impaction plate. It's major feature is the nozzle-to-plate separation, L. The particle size collected changes with L and thus, particle size spectroscopy is achieved by varying L. The number of collected particles is determined by alpha spectroscopy. The size-discriminating ability of the system was tested with laboratory generated radon particles and it was subsequently used to characterize the physical (size) changes associated with the interaction of radon progeny with water vapor and short chain alcohols in various support gases. The theory of both traditional and high velocity jet impactors together with the design and evaluation of the system developed in this study are discussed in various chapters of this dissertation. The major results obtained in the course of the study are also presented.

30563 (MLM–108) **A study of the Quartz Fiber Balance No. 1 (Information Report).** Haring, M.M. Mound, Miamisburg, OH (United States). 1 Aug 1945. 7p. Sponsored by USDOE, Washington, DC (United States). DOE Contract AC24-88DP43495. Order Number DE96000789. Source: OSTI; NTIS; GPO Dep.

This article is a de-classified document produced by Monsanto Chemical Company-Unit III in Dayton, Ohio. The date of the document is August 1, 1945, and the subject is the operation of a quartz fiber microbalance. In particular, the document examines whether temperature fluctuations affect the operation of the instrument. Data was presented to show that the accuracy of the instrument was indeed affected by ambient temperature.

30564 (UCRL-JC–120825) **Comparison between predicted and actual accuracies for an Ultra-Precision CNC measuring machine.** Thompson, D.C.; Fix, B.L. Lawrence Livermore National Lab., CA (United States). 30 May 1995. 6p. Sponsored by USDOE, Washington, DC (United States). DOE Contract W-7405-ENG-48. (CONF-9505290–1: 8. international precision engineering seminar, Compiegne (France), 15-19 May 1995). Order Number DE96001316. Source: OSTI; NTIS; GPO Dep.

At the 1989 CIRP annual meeting, we reported on the design of a specialized, ultra-precision CNC measuring machine, and on the error budget that was developed to guide the design process. In our paper we proposed a combinatorial rule for merging estimated and/or calculated values for all known sources of error, to yield a single overall predicted accuracy for the machine. In this paper we compare our original predictions with measured performance of the completed instrument.

30565 (UCRL-JC–121519) **Improved shock-detection pin arrangement.** Erskine, D.J. Lawrence Livermore National Lab., CA (United States). Aug 1995. 3p. Sponsored by USDOE, Washington, DC (United States). DOE Contract W-7405-ENG-48. (CONF-950846–55: American Physical Society biennial conference on shock compression of condensed matter, Seattle, WA (United States), 13-18 Aug 1995). Order Number DE95017071. Source: OSTI; NTIS; GPO Dep.

Shockwave speeds are often measured by comparing arrival times at the tips of electrical shorting pins in a hexagonal array over two elevations (called up and down). In the conventional arrangement, the center pin is solely responsible for measuring the curvature of the wavefront. Without this datum the shock speed cannot be precisely determined. In some experiments this pin fail frequently enough to be a problem. We report a simple rearrangement between up and down designated pins which eliminates the critical reliance on a single.

30566 (UCRL-JC–121521) **Increase of the dynamic range of catchup experiments by high-pass filtering.** Erskine, D.J. Lawrence Livermore National Lab., CA (United States). Aug 1995. 4p. Sponsored by USDOE, Washington, DC (United States). DOE Contract W-7405-ENG-48. (CONF-950846–54: American Physical Society biennial conference on shock compression of condensed matter, Seattle, WA (United States), 13-18 Aug 1995). Order Number DE95017072. Source: OSTI; NTIS; GPO Dep.

The release-catchup shock experiment is an important tool for measuring the speed of sound in compressed matter. The catchup of the release wave to the leading shock is sensitively detected optically, through an indicating fluid which produces light approximately to the 4th power of the shock pressure. However, this sensitivity demands a dynamic range which exceeds the capabilities of our digitizer. The catchup signature lies at the top of a flat pulse, thus any signal clipping is a catastrophic loss of data. We have invented a simple and accurate method for recording the catchup signature that is insensitive to signal clipping. A high pass circuit prior to the digitizer is used with post experiment integration.

The insensitivity to clipping allows recording the catchup signature at higher gain, and thus with an improved signal to noise ratio.

45 MILITARY TECHNOLOGY, WEAPONRY, AND NATIONAL DEFENSE

Refer also to citation(s) 30277, 30314, 30376, 30552, 30554, 31349

30567 (LA-SUB–93-176) **Economic impacts study.** Brunsen, W.; Worley, W.; Frost, E. Los Alamos National Lab., NM (United States). 30 Sep 1988. 35p. Sponsored by Department of Defense, Washington, DC (United States). DOE Contract W-7405-ENG-36. Order Number DE96000171. Source: OSTI; NTIS; GPO Dep.

This is a progress report on the first phase of a project to measure the economic impacts of a rapidly changing U.S. target base. The purpose of the first phase is to designate and test the macroeconomic impact analysis model. Criteria were established for a decision-support model. Additional criteria were defined for an interactive macroeconomic impact analysis model. After a review of several models, the Economic Impact Forecast System model of the U.S. Army Construction Research Laboratory was selected as the appropriate input-output tool that can address local and regional economic analysis. The model was applied to five test cases to demonstrate its utility and define possible revisions to meet project criteria. A plan for EIFS access was defined at three levels. Objectives and tasks for scenario refinement are proposed.

30568 (LA-SUB–93-183) **Technical analysis of US Army Weapons Systems and related advanced technologies of military interest. Final report.** Los Alamos National Lab., NM (United States). 14 Jun 1991. 350p. Sponsored by Department of Defense, Washington, DC (United States). DOE Contract W-7405-ENG-36. Order Number DE96000184. Source: OSTI; NTIS; GPO Dep.

This report summarizes the activities and accomplishments of an US Army technology security project designed to identify and develop effective policy guidelines for militarily critical technologies in specific Army systems and in broad generic technology areas of military interest. Individual systems analyses are documented in separate Weapons Systems Technical Assessments (WSTAs) and the general generic technology areas are evaluated in the Advanced Technology Assessment Reports (ATARs), However, specific details of these assessments are not addressed here, only recommendations regarding aspects of the defined approach, methodology, and format are provided and discussed.

30569 (ORNL/TM–13027) **A liquid over-feeding military air conditioner.** Mei, V.C.; Chen, F.C. Oak Ridge National Lab., TN (United States). Jul 1995. 25p. Sponsored by Department of the Army, Washington, DC (United States). DOE Contract AC05-84OR21400. Order Number DE95016385. Source: OSTI; NTIS; GPO Dep.

A 3.3-ton military air conditioning unit has been studied experimentally in both baseline (as received) and as modified for liquid over-feeding (LOF) operation. Tne baseline test, using a proper refrigerant charge, showed the measured cooling capacity to be less than 1% off the rated capacity at 95°F ambient temperature. The test results indicate that LOF operation outperforms the baseline case over a wide ambient temperature range in terms of cooling capacity, power consumption, and system coefficient of performance (COP). At a 95°F test point, LOF operation has a cooling capacity of 51,100 BTU per hour, which is a 28.9% improvement over the baseline operation capacity of 39,600 BTU per hour. The COP for LOF at 95°F is 2.62, which is 29% better than the baseline COP of 2.03. However, an optimal refrigerant charge is essential for LOF to work properly.

30570 (SAND–95-1329C) **A survey of early warning technologies.** Smith, G.D.; Arlowe, H.D.; Williams, J.D. Sandia National Labs., Albuquerque, NM (United States). [1995]. 7p. Sponsored by Department of Defense, Washington, DC (United States). DOE Contract AC04-94AL85000. (CONF-950787–58: 36. annual meeting of the Institute for Nuclear Materials Management, Palm Desert, CA (United States), 9-12 Jul 1995). Order Number DE95014847. Source: OSTI; NTIS; GPO Dep.

This paper presents a survey of technologies useful in providing early warning in physical security systems. Early warning is important in virtually all types of security systems whether they are used for temporary (tactical, portable, or semi-permanent) applications, border warning, fixed-site detection, or standoff surveillance detection. With the exception of the standoff surveillance detection systems, all systems discussed in this paper usually involve a moving target. The fact that a person(s) to be detected in a standoff surveillance scenario is not moving presents challenging problems and requires different applications of technology. The technologies commonly used to detect moving targets and some suggestions for detection of stationary targets are addressed in this paper.

30571 (SAND–95-1433C) **Remote video assessment for missile launch facilities.** Wagner, G.G.; Stewart, W.A. Sandia National Labs., Albuquerque, NM (United States). [1995]. 4p. Sponsored by Department of Defense, Washington, DC (United States). DOE Contract AC04-94AL85000. (CONF-950787–57: 36. annual meeting of the Institute for Nuclear Materials Management, Palm Desert, CA (United States), 9-12 Jul 1995). Order Number DE95014846. Source: OSTI; NTIS; GPO Dep.

The widely dispersed, unmanned launch facilities (LFs) for land-based ICBMs (intercontinental ballistic missiles) currently do not have visual assessment capability for existing intrusion alarms. The security response force currently must assess each alarm on-site. Remote assessment will enhance manpower, safety, and security efforts. Sandia National Laboratories was tasked by the USAF Electronic Systems Center to research, recommend, and demonstrate a cost-effective remote video assessment capability at missile LFs. The project's charter was to provide: system concepts; market survey analysis; technology search recommendations; and operational hardware demonstrations for remote video assessment from a missile LF to a remote security center via a cost-effective transmission medium and without using visible, on-site lighting. The technical challenges of this project were to: analyze various video transmission media and emphasize using the existing missile system copper line which can be as long as 30 miles; accentuate and extremely low-cost system because of the many sites requiring system installation; integrate the video assessment system with the current LF alarm system; and provide video assessment at the remote sites with non-visible lighting.

30572 (SAND–95-1551/1) **1994 Triggered Lightning Test Program: Measured responses of a reinforced concrete building under direct lightning attachments.** Schnetzer, G.H. (Sandia National Labs., Albuquerque, NM (United States)); Chael, J.; Davis, R.; Fisher, R.J.; Magnotti, P.J. Sandia National Labs., Albuquerque, NM (United States). Aug 1995. 94p. Sponsored by USDOE, Washington, DC (United States). DOE Contract AC04-94AL85000. Order Number DE95017635. Source: OSTI; NTIS; GPO Dep.

A rocket-triggered lightning test was carried out during the summer of 1994 on a specially designed steel reinforced concrete test building located at Ft. McClellan, Alabama. Currents, voltages, and magnetic fields were measured at 24 instrumented locations during 42 return strokes triggered to designated points on the structure and its lightning protection systems. As was found during an earlier similar lightning test of an earth covered munitions storage building, the buried power service conduits carried a much larger fraction of incident stroke current away from the building than did the intended grounding elements of the lightning protection system. Electrical breakdown and subsequent arcing occurred repeatedly to create dominant current paths to earth that were not accounted for in pretest linear modeling. Potential hazard level transient voltages, surprisingly more resistive than inductive in nature, were recorded throughout the structure. Also surprisingly, strikes to a single grounded protection mast system resulted in internal environments that were generally comparable to those occurring during strikes to roof-mounted air terminals. A description of the test structure, experimental procedures, and a full set of the resultant data are presented in this two-volume report.

30573 (SAND–95-1841) **A cost-effective adverse-weather precision guidance system.** Fellerhoff, R.; Burgett, S. Sandia National Labs., Albuquerque, NM (United States). Aug 1995. 31p. Sponsored by USDOE, Washington, DC (United States). DOE

Contract AC04-94AL85000. Order Number DE96000206. Source: OSTI; NTIS; GPO Dep.

This SAND report documents the results of an LDRD project undertaken to study the accuracy of terrain-aided navigation coupled with highly accurate topographic maps. A revolutionary new mapping technology, interferometric synthetic aperture radar (IFSAR), has the ability to make terrain maps of extremely high accuracy and spatial resolution, more than an order of magnitude better than currently available DMA map products. Using a laser altimeter and the Sandia Labs Twin Otter Radar Testbed, fix accuracies of less than 3 meters CEP were obtained over urban and natural terrain regions.

30574 (SAND–95-2128) **Aqueous foam toxicology evaluation and hazard review.** Archuleta, M.M. Sandia National Labs., Albuquerque, NM (United States). Oct 1995. 22p. Sponsored by USDOE, Washington, DC (United States). DOE Contract AC04-94AL85000. Order Number DE96001328. Source: OSTI; NTIS; GPO Dep.

Aqueous foams are aggregates of bubbles mechanically generated by passing air or other gases through a net, screen, or other porous medium that is wetted by an aqueous solution of surface-active foaming agents (surfactants). Aqueous foams are important in modern fire-fighting technology, as well as for military uses for area denial and riot or crowd control. An aqueous foam is currently being developed and evaluated by Sandia National Laboratories (SNL) as a Less-Than-Lethal Weapon for the National Institute of Justice (NIJ). The purpose of this study is to evaluate the toxicity of the aqueous foam developed for the NIJ and to determine whether there are any significant adverse health effects associated with completely immersing individuals without protective equipment in the foam. The toxicity of the aqueous foam formulation developed for NIJ is determined by evaluating the toxicity of the individual components of the foam. The foam is made from a 2–5% solution of Steol CA-330 surfactant in water generated at expansion ratios ranging from 500:1 to 1000:1. Steol CA-330 is a 35% ammonium laureth sulfate in water and is produced by Stepan Chemical Company and containing trace amounts (<0.1%) of 1,4-dioxane. The results of this study indicate that Steol CA-330 is a non-toxic, mildly irritating, surfactant that is used extensively in the cosmetics industry for hair care and bath products. Inhalation or dermal exposure to this material in aqueous foam is not expected to produce significant irritation or systemic toxicity to exposed individuals, even after prolonged exposure. The amount of 1,4-dioxane in the surfactant, and subsequently in the foam, is negligible and therefore, the toxicity associated with dioxane exposure is not significant. In general, immersion in similar aqueous foams has not resulted in acute, immediately life-threatening effects, or chronic, long-term, non-reversible effects following exposure.

30575 (UCRL-CR–121818) **Experimental study of ELF signatures developed by ballistic missile launch.** Peglow, S.G.; Rynne, T.M. Lawrence Livermore National Lab., CA (United States). 8 Apr 1993. 33p. Sponsored by USDOE, Washington, DC (United States). DOE Contract W-7405-ENG-48. Order Number DE96000352. Source: OSTI; NTIS; GPO Dep.

The Lawrence Livermore National Laboratory (Livermore, CA) and SARA, Inc. participated in the ATMD missile launch activities that occurred at WSMR during January 1993. These tests involved the launch of Lance missiles with a subsequent direction of F-15Es into the launch area for subsequent detection and simulated destruction of redeployed missile launchers, LLNL and SARA deployed SARN's ELF sensors and various data acquisition systems for monitoring of basic phenomena. On 25 January 1993, a single missile launch allowed initial measurements of the phenomena and an assessment of appropriate sensor sensitivity settings as well as the appropriateness of the sensor deployment sites (e.g., with respect to man-made ELF sources such as power distributions and communication lines). On 27 January 1993, a measurement of a double launch of Lance missiles was performed. This technical report covers the results of the analysis of latter measurements. An attempt was made to measure low frequency electromagnetic signatures that may be produced during a missile launch. Hypothetical signature production mechanisms include: (1) Perturbations of the earth geo-potential during the launch of the missile. This signature may arise from the interaction of the ambient electric field with the conducting body of the missile as well as the partially ionized exhaust plume. (2) Production of spatial, charge sources from triboelectric-like mechanisms. Such effects may occur during the initial interaction of the missile plume with the ground material and lead to an initial "spike" output, Additionally, there may exist charge transfer mechanisms produced during the exhausting of the burnt fuel oxidizer.

30576 (UCRL-ID–20736) **An implementation of a medium resolution minefield model in the Joint Conflict Model.** Pimper, J.E.; Matone, J. Lawrence Livermore National Lab., CA (United States). 13 Jan 1995. 23p. Sponsored by USDOE, Washington, DC (United States). DOE Contract W-7405-ENG-48. Order Number DE95011600. Source: OSTI; NTIS; GPO Dep.

An implementation of a new, flexible, and realistic representation of conventional minefields in the Joint Conflict Model (JCM) is presented. The model includes important aspects of minefield effects on battlefield entities and of breaching devices on minefields. The model is designed at "medium resolution," that is, it is general enough to depict a wide variety of tactical situations accurately; however, it only represents tactically significant aspects of mine warfare, discarding or aggregating details, thus minimizing computer memory and speed requirements. This paper describes the model in detail, its implementation in the JCM simulation code, and its use in a preliminary analysis effort related to the effect of delay on the tactical battlefield.

30577 (UCRL-ID–121669) **Landmine detection and imaging using Micropower Impulse Radar (MIR).** Azevedo, S.G.; Gravel, D.T.; Mast, J.E.; Warhus, J.P. Lawrence Livermore National Lab., CA (United States). 7 Aug 1995. 8p. Sponsored by USDOE, Washington, DC (United States). DOE Contract W-7405-ENG-48. Order Number DE96000870. Source: OSTI; NTIS; GPO Dep.

The Lawrence Livermore National Laboratory (LLNL) has developed radar and imaging technologies with potential applications in mine detection by the armed forces and other agencies involved in determining efforts. These new technologies use a patented ultra-wideband (impulse) radar technology that is compact, low-cost, and low power. Designated as Micropower hnpulse Radar, these compact, self-contained radars can easily be assembled into arrays to form complete ground penetrating radar imaging systems. LLNL has also developed tomographic reconstruction and signal processing software capable of producing high-resolution 2-D and 3-D images of objects buried in materials like soil or concrete from radar data. Preliminary test results have shown that a radar imaging system using these technologies has the ability to image both metallic and plastic land mine surrogate targets buried in 5 to 10 cm of moist soil. In dry soil, the system can detect buried objects to a depth of 30 cm and more. This report describes our initial test results and plans for future work.

30578 (UCRL-JC–119497) **Adaptive ocean acoustic processing for a shallow ocean experiment.** Candy, J.V. (Lawrence Livermore National Lab., CA (United States)); Sullivan, E.J. Lawrence Livermore National Lab., CA (United States). 19 Jul 1995. 6p. Sponsored by USDOE, Washington, DC (United States). DOE Contract W-7405-ENG-48. (CONF-9510202–2: Oceans '95, San Diego, CA (United States), 9-12 Oct 1995). Order Number DE96000077. Source: OSTI; NTIS; GPO Dep.

A model-based approach is developed to solve an adaptive ocean acoustic signal processing problem. Here we investigate the design of model-based identifier (MBID) for a normal-mode model developed from a shallow water ocean experiment and then apply it to a set of experimental data demonstrating the feasibility of this approach. In this problem we show how the processor can be structured to estimate the horizontal wave numbers directly from measured pressure sound speed thereby eliminating the need for synthetic aperture processing or a propagation model solution. Ocean acoustic signal processing has made great strides over the past decade necessitated by the development of quieter submarines and the recent proliferation of diesel powered vessels.

30579 (UCRL-JC–119498) **Model-based localization for a shallow ocean experiment.** Candy, J.V. (Lawrence Livermore National Lab., CA (United States)); Sullivan, E.J. Lawrence Livermore

National Lab., CA (United States). 19 Jul 1995. 8p. Sponsored by USDOE, Washington, DC (United States). DOE Contract W-7405-ENG-48. (CONF-9510202–3: Oceans '95, San Diego, CA (United States), 9-12 Oct 1995). Order Number DE96000097. Source: OSTI; NTIS; GPO Dep.

In this paper a modern approach was developed to solve the passive localization problem in ocean acoustics using the state-space formulation. It is shown that the inherent structure of the resulting processor consists of a parameter estimator coupled to a nonlinear optimization scheme. The parameter estimator is design using an acoustic propagation model in developing the modern identifier required for localization. The detection and localization of an acoustic source has long been the motivation of early sonar systems. With the advent of quieter and quieter submarines due to new manufacturing technologies and the next proliferation of diesel powered vessels, the need for more sophisticated processing techniques has been apparent for quite some time.

30580 (UCRL-JC–120710) **Land mine detection using multi-spectral image fusion.** Clark, G.A.; Sengupta, S.K.; Aimonetti, W.D.; Roeske, F.; Donetti, J.G.; Fields, D.J.; Sherwood, R.J.; Schaich, P.C. Lawrence Livermore National Lab., CA (United States). 29 Mar 1995. 12p. Sponsored by USDOE, Washington, DC (United States). DOE Contract W-7405-ENG-48. (CONF-9504154–4: Symposium on autonomous vehicles in mine countermeasures, Monterey, CA (United States), 3-7 Apr 1995). Order Number DE95017825. Source: OSTI; NTIS; GPO Dep.

Our system fuses information contained in registered images from multiple sensors to reduce the effects of clutter and improve the ability to detect surface and buried land mines. The sensor suite currently consists of a camera that acquires images in six bands (400nm, 500nm, 600nm, 700nm, 800nm and 900nm). Past research has shown that it is extremely difficult to distinguish land mines from background clutter in images obtained from a single sensor. It is hypothesized, however, that information fused from a suite of various sensors is likely to provide better detection reliability, because the suite of sensors detects a variety of physical properties that are more separable in feature space. The materials surrounding the mines can include natural materials (soil, rocks, foliage, water, etc.) and some artifacts. We use a supervised learning pattern recognition approach to detecting the metal and plastic land mines. The overall process consists of four main parts: Preprocessing, feature extraction, feature selection, and classification. These parts are used in a two step process to classify a subimage. We extract features from the images, and use feature selection algorithms to select only the most important features according to their contribution to correct detections. This allows us to save computational complexity and determine which of the spectral bands add value to the detection system. The most important features from the various sensors are fused using a supervised learning pattern classifier (the probabilistic neural network). We present results of experiments to detect land mines from real data collected from an airborne platform, and evaluate the usefulness of fusing feature information from multiple spectral bands.

30581 (UCRL-JC–121595) **On the possibility of altering the trajectories of asteroids and comets using plutonium implantation.** Chapline, G.; Howard, M. Lawrence Livermore National Lab., CA (United States). 20 Jul 1995. 9p. Sponsored by USDOE, Washington, DC (United States). DOE Contract W-7405-ENG-48. (CONF-9505266–3: Planetary defense workshop, Livermore, CA (United States), 22-26 May 1995). Order Number DE95017873. Source: OSTI; NTIS; GPO Dep.

It is pointed out that creation of a critical assembly by implantation of Pu239 inside an asteroid or comet could produce a substantial force on the asteroid or comet due to either explosive ejection or asymmetric sublimation of material off the surface of the asteroid or comet. This would allow one to make substantial changes in an asteroid's or comet's orbital elements using existing launch vehicles and spacecraft technology. It is particularly intriguing that recurrent sublimation induced by plutonium implantation could over a few months time deflect even kilometer-sized earth intersecting objects enough to avoid the earth. For the more distant future, nuclear-powered pulse jets might be a cost-effective way of altering the trajectories of asteroids and comets.

4501 Chemical Explosions and Explosives

Refer also to citation(s) 29985, 29986, 30257, 30295, 30620

30582 (LA–13003) **Chemical destruction of HMX-based explosives with ammonium hydroxide.** Skidmore, C.; Dell'Orco, P.; Flesner, R.; Kramer, J.; Spontarelli, T. Los Alamos National Lab., NM (United States). Sep 1995. 16p. Sponsored by USDOE, Washington, DC (United States). DOE Contract W-7405-ENG-36. Order Number DE96000052. Source: OSTI; NTIS; GPO Dep.

A series of experiments at Los Alamos National Laboratory explored the efficacy of ammonium hydroxide solutions in converting HMX (cyclotetramethylene-tetranitramine, or Octogen) and HMX-based explosives to nonenergetic, nonhazardous materials. When 80 g of explosive was converted in a reactor operating at 85 psig pressure at 140 C, the principal gaseous products were nitrous oxide (46% to 51%), nitrogen (22% to 32%), and ammonia (17% to 28%). Formate and hexamethylene-tetramine (hexamine) account for effectively 100% of the carbon-bearing aqueous species. Nitrate, nitrite, and acetate were present in the liquid in trace amounts. The process effectively treated molding powders of the plastic-bonded explosives PBX 9501 (2.5% estane), LX-04 (15% viton), and PBX 9404 (3% nitrocellulose). Results were compared with those achieved using sodium hydroxide solutions at 150 C in a pressurized reactor.

30583 (LA-SUB–95-106) **A dynamic explosive model for MACH2 with applications to magnetic flux compression generators.** Watrous, J.J. (NumerEx, Albuquerque, NM (United States)); Frese, M.H. Los Alamos National Lab., NM (United States); NumerEx, Albuquerque, NM (United States). 2 Mar 1993. 31p. Sponsored by USDOE, Washington, DC (United States). DOE Contract W-7405-ENG-36. Order Number DE95017362. Source: OSTI; NTIS; GPO Dep.

An explosive model has recently been designed and added to MACH2 to enable that code to be used as a tool for studying explosive magnetic flux compression generators. This report describes this model and gives examples of its use in both one- and two-dimensional simulations. A description of the model is given and one-dimensional simulations will be discussed. Also, we show examples of two-dimensional simulations. Appendices contain input decks for the one- and two-dimensional simulations and a listing of the modifications made to MACH2 for this purpose.

30584 (LA-UR–95-831) **Life-cycle assessment (LCA) methodology applied to energetic materials.** Reardon, P.T. Los Alamos National Lab., NM (United States). [1995]. 8p. Sponsored by Department of Defense, Washington, DC (United States). DOE Contract W-7405-ENG-36. (CONF-951218–1: Life cycles of energetic materials conference, Del Mar, CA (United States), 11-16 Dec 1995). Order Number DE95007845. Source: OSTI; NTIS; GPO Dep.

The objective of the Clean Agile Manufacturing of Propellants, Explosives, and pyrotechnics (CAMPEP) program is to develop and demonstrate the feasibility of using modeling, alternate materials and processing technology to reduce PEO life-cycle pollution by up to 90%. Traditional analyses of factory pollution treat the manufacturing facility as the singular pollution source. The life cycle of a product really begins with raw material acquisition and includes all activities through ultimate disposal. The life cycle thus includes other facilities besides the principal manufacturing facility. The pollution generated during the product life cycle is then integrated over the total product lifetime, or represents a "cradle to grave" accounting philosophy. This paper addresses a methodology for producing a life-cycle inventory assessment.

30585 (LA-UR–95-2491) **Modeling cylinder test.** Tang, P.K.; Scannapieco, A.J. Los Alamos National Lab., NM (United States). [1995]. 5p. Sponsored by USDOE, Washington, DC (United States). DOE Contract W-7405-ENG-36. (CONF-950846–16: American Physical Society biennial conference on shock compression of condensed matter, Seattle, WA (United States), 13-18 Aug 1995). Order Number DE95016997. Source: OSTI; NTIS; INIS; GPO Dep.

The dynamic behavior of a copper tube containing high explosive PBX 9502 is studied. The detonation of the explosive propagating

along the axis drives the copper tube radially outward. A multi-process reactive model is used to simulate the explosive burn behavior in an Eulerian hydrodynamic code. In addition,an adaptive mesh refinement technique is featured in controlling the computational mesh size as the detonation wave moves in and out of a region. Comparison with experiments is made to show the capability of the new hydrocode.

30586 (LA-UR–95-2764) **Low pressure shock initiation of porous HMX for two grain size distributions and two densities.** Gustavsen, R.L.; Sheffield, S.A.; Alcon, R.R. Los Alamos National Lab., NM (United States). [1995]. 6p. Sponsored by USDOE, Washington, DC (United States);Department of Defense, Washington, DC (United States). DOE Contract W-7405-ENG-36. (CONF-950846–28: American Physical Society biennial conference on shock compression of condensed matter, Seattle, WA (United States), 13-18 Aug 1995). Order Number DE95016937. Source: OSTI; NTIS; GPO Dep.

Shock initiation measurements have been made on granular HMX (octotetramethylene tetranitrainine) for two particle size distributions and two densities. Samples were pressed to either 65% or 73% of crystal density from fine ($\approx$ 10 μm grain size) and coarse (broad distribution of grain sizes peaking at $\approx$ 150 μm) powders. Planar shocks of 0.2–1 GPa were generated by impacting gas gun driven projectiles on plastic targets containing the HMX. Wave profiles were measured at the input and output of the $\approx$ 3.9 mm thick HMX layer using electromagnetic particle velocity gauges. The initiation behavior for the two particle size distributions was very different. The coarse HMX began initiating at input pressures as low as 0.5 GPa. Transmitted wave profiles showed relatively slow reaction with most of the buildup occurring at the shock front. In contrast, the fine particle HMX did not begin to initiate at pressures below 0.9 GPa. When the fine powder did react, however, it did so much faster than the coarse HMX. These observations are consistent with commonly held ideas about burn rates being correlated to surface area, and initiation thresholds being correlated with the size and temperature of the hot spots created by shock passage. For each size, the higher density pressings were less sensitive than the lower density pressings.

30587 (LA-UR–95-2818) **Calibration and use of a rugged new piezoresistive pressure transducer.** Lucht, R.A.; Charest, J.A. Los Alamos National Lab., NM (United States). [1995]. 5p. Sponsored by USDOE, Washington, DC (United States). DOE Contract W-7405-ENG-36. (CONF-950914–4: American Nuclear Society international topical conference on the safety of operating reactors, Seattle, WA (United States), 17-23 Sep 1995). Order Number DE95016930. Source: OSTI; NTIS; GPO Dep.

A new 50-ohm piezoresistive pressure gauge has been developed and calibrated in the range 0 to 4.0 GPa. This "pinducer" consists of one half of 100 ohm, one quarter watt, carbon composition resistor mounted coaxially at the end of a small brass tube. Three techniques have been used to calibrate this new gauge. Good agreement is found between all calibration data, and a smooth curve is fit through all resistance change versus pressure data up to 1.5 GPa. The gauges exhibit rise times of about 0.5 μs. They offer advantages in raggedness, cost, and flexibility of application. The pinducer can be successfully used in divergent flows, harsh environments, and positions where lead protection would be impossible with thin-film gauges. A unique application is demonstrated.

30588 (LA-UR–95-2875) **Inert plug formation in the DDT of granular energetic materials.** Son, S.F.; Asay, B.W.; Bdzil, J.B. Los Alamos National Lab., NM (United States). [1995]. 5p. Sponsored by USDOE, Washington, DC (United States). DOE Contract W-7405-ENG-36. (CONF-950846–49: American Physical Society biennial conference on shock compression of condensed matter, Seattle, WA (United States), 13-18 Aug 1995). Order Number DE96000001. Source: OSTI; NTIS; GPO Dep.

A mechanism is proposed to explain the "plugs" that have been observed in deflagration-to-detonation transition (DDT) of granular explosives. Numerical simulations are performed that demonstrate the proposed mechanism. Observed trends are reproduced.

30589 (LA-UR–95-2956) **Measurement of the stress/strain response of energetic materials as a function of strain rate and temperature: PBX 9501 and Mock 9501.** Funk, D.J.; Laabs, G.W.; Peterson, P.D.; Asay, B.W. Los Alamos National Lab., NM (United States). [1995]. 5p. Sponsored by USDOE, Washington, DC (United States). DOE Contract W-7405-ENG-36. (CONF-950846–59: American Physical Society biennial conference on shock compression of condensed matter, Seattle, WA (United States), 13-18 Aug 1995). Order Number DE96000025. Source: OSTI; NTIS; GPO Dep.

We have measured the stress/strain behavior of PBX 9501, Mock 900-21 and two new mocks consisting of monoclinic granular sugar embedded in (1) a BDNPA-F/estane binder (a 9501 material mock; a hard organic crystal embedded in a plastic) and (2) neat estane (an LX-14 mock) at strain rates from 10^{-3} to 10^{-1}, at two L/D's and at two temperatures (25 and 60 C). We find that the compressive strength falls with increasing temperature and rises with increasing strain rate. We also find that the new 9501 sugar mock most closely resembles the behavior of the 9501 explosive and differences may be attributable to the different ages of the estane binder used.

30590 (SAND–94-3060C) **Equilibrium calculations of firework mixtures.** Hobbs, M.L. (Sandia National Labs., Albuquerque, NM (United States)); Tanaka, Katsumi; Iida, Mitsuaki; Matsunaga, Takehiro. Sandia National Labs., Albuquerque, NM (United States). [1994]. 7p. Sponsored by USDOE, Washington, DC (United States). DOE Contract AC04-94AL85000. (CONF-9511132–1: 3. international symposium on pyrotechnics and explosives, Beijing (China), 6-9 Nov 1995). Order Number DE96000705. Source: OSTI; NTIS; GPO Dep.

Thermochemical equilibrium calculations have been used to calculate detonation conditions for typical firework components including three report charges, two display charges, and black powder which is used as a fuse or launch charge. Calculations were performed with a modified version of the TIGER code which allows calculations with 900 gaseous and 600 condensed product species at high pressure. The detonation calculations presented in this paper are thought to be the first report on the theoretical study of firework detonation. Measured velocities for two report charges are available and compare favorably to predicted detonation velocities. However, the measured velocities may not be true detonation velocities. Fast deflagration rather than an ideal detonation occurs when reactants contain significant amounts of slow reacting constituents such as aluminum or titanium. Despite such uncertainties in reacting pyrotechnics, the detonation calculations do show the complex nature of condensed phase formation at elevated pressures and give an upper bound for measured velocities.

30591 (UCRL-CR–121838) **SERDP munition disposal source characterization pilot study.** McCallen, R.C. (and others); Couch, R.G.; Fried, L.E. Lawrence Livermore National Lab., CA (United States). Sep 1995. 60p. Sponsored by USDOE, Washington, DC (United States). DOE Contract W-7405-ENG-48. Order Number DE96000374. Source: OSTI; NTIS; GPO Dep.

The Strategic Environmental Research and Development Program (SERDP) is supporting studies to develop and implement technologies for the safe, efficient, and environmentally sound disposal of obsolete munitions and propellants which are stored at various locations across the country. One proposed disposal technique is the open-air burning or detonation (OB/OD) of this material. Although OB/OD is viewed as an efficient and cost-effective method for reducing the inventory of unwanted munitions and propellants, questions regarding its safety and environmental impacts must be addressed. Since very large amounts of munitions and propellants must be consumed inexpensively in relatively short time periods and with the very restrictive Federal and State regulations on environmental issues, it is clear that traditional OB/OD procedures will not be acceptable and that it is necessary to develop modified or advanced OB/OD technology. The effectiveness and environmental impact of the OB/OD technology must be verified by experimental data and with validated numerical models for acceptance by Federal and State regulators. Specifically, technology must be developed and tested that minimizes toxic burn and

detonation products the noise (peak pressure) and destructive effect (impulse) of the explosive blast generation and travel distance of shrapnel, and entrainment of dust. Three explosion attenuation scenarios are analyzed: Contained water, aqueous foams, and wet sand.

30592 (UCRL-ID–118676) **Second test of base hydrolysate decomposition in a 0.04 gallon per minute scale reactor.** Cena, R.J.; Thorsness, C.B.; Coburn, T.T.; Watkins, B.E. Lawrence Livermore National Lab., CA (United States). 11 Oct 1994. 13p. Sponsored by USDOE, Washington, DC (United States). DOE Contract W-7405-ENG-48. Order Number DE95017036. Source: OSTI; NTIS; GPO Dep.

LLNL has built and operated a pilot plant for processing oil shale using recirculating hot solids. This pilot plant, was adapted in 1993 to demonstrate the feasibility of decomposing base hydrolysate, a mixture of sodium nitrite, sodium formate and other constituents. This material is the waste stream from the base hydrolysis process for destruction of energetic materials. In the Livermore process, the waste feed is thermally treated in a moving packed bed of ceramic spheres, where constituents in the waste decompose, in the presence of carbon dioxide, to form solid sodium carbonate and a suite of gases including: methane, carbon monoxide, oxygen, nitrogen oxides, ammonia and possibly molecular nitrogen. The ceramic spheres are circulated and heated, providing the energy required for thermal decomposition. The spheres provide a large surface area for evaporation and decomposition to occur, avoiding sticking and agglomeration of the waste. We performed a 2.5 hour test of the solids recirculation system, with continuous injection of approximately 0.04 gal/min of waste. Gasses from the packed bed reactor were directed through the lift pipe and water was not condensed. Potassium carbonate (0.356 M) was added to the hydrolysate prior to its introduction to the retort. Continuous on-line gas analysis was invaluable in tracking the progress of the experiment and quantifying the decomposition products. Analyses showed the primary solid product, collected in the lift exit cyclone, was indeed sodium carbonate, as expected. For the reactor condition studied in this test, N_2O was found to be the primary nitrogen bearing gas species. In the test, approximately equal quantities of ammonia and nitrogen bearing oxide gases were produced. Under proper conditions, this ammonia and NO_x can be recombined downstream to form N_2 and O_2 as the primary effluent gases.

30593 (UCRL-ID–121755) **Results of a preliminary assessment of an explosive projectile launch system.** Reaugh, J.E. Lawrence Livermore National Lab., CA (United States). 31 Jul 1995. 12p. Sponsored by USDOE, Washington, DC (United States). DOE Contract W-7405-ENG-48. Order Number DE95017301. Source: OSTI; NTIS; GPO Dep.

This report presents results on a preliminary assessment of accelerating a projectile by a sequence of timed explosions. Computerized simulations were performed with CALE, a two-dimensional Arbitrary Language Eulerian program to examine principles and preferred operating parameters.

30594 (UCRL-JC–11737-R1) **Coupled thermal/chemical/mechanical modeling of insensitive explosives in thermal environments.** Nichols, A.L. III. Lawrence Livermore National Lab., CA (United States). 7 Aug 1995. 6p. Sponsored by USDOE, Washington, DC (United States). DOE Contract W-7405-ENG-48. (CONF-950846–44: American Physical Society biennial conference on shock compression of condensed matter, Seattle, WA (United States), 13-18 Aug 1995). Order Number DE96000349. Source: OSTI; NTIS; GPO Dep.

The ability to predict the response of a weapon system that contains insensitive explosives to elevated temperatures is important in understanding its safety characteristics. To model such a system at elevated temperatures in a finite element computer code requires a variety of capabilities. These modeling capabilities include thermal diffusion and convection to transport the heat to the explosives in the weapon system, temperature based chemical reaction modeling of the decomposition of the explosive materials, and mechanical modeling of both the metal casing and the unreacted and decomposed explosive. The Chemical TOPAZ code has been developed to model coupled thermal/chemical problems where we do not need to model the mass motion.

30595 (UCRL-JC–119253) **Clean, agile alternative binders, additives and plasticizers for propellant and explosive formulations.** Hoffman, D.M. (Lawrence Livermore National Lab., CA (United States)); Hawkins, T.W.; Lindsay, G.A. Lawrence Livermore National Lab., CA (United States). Dec 1994. 20p. Sponsored by USDOE, Washington, DC (United States). DOE Contract W-7405-ENG-48. (CONF-941255–5: Life cycles of energetic materials, Del Mar, CA (United States), 11-16 Dec 1994). Order Number DE95017292. Source: OSTI; NTIS; GPO Dep.

As part of the Strategic Environmental Research and Development Program (SERDP) a clean, agile manufacturing of explosives, propellants and pyrotechniques (CANPEP) effort set about to identify new approaches to materials and processes for producing propellants, explosives and pyrotechniques (PEP). The RDX based explosive PBXN-109 and gun propellant M-43 were identified as candidates for which waste minimization and recycling modifications might be implemented in a short time frame. The binders, additives and plasticizers subgroup identified cast non-curable thermoplastic elastomer (TPE) formulations as possible replacement candidates for these formulations. Paste extrudable explosives were also suggested as viable alternatives to PBXN-109. Commercial inert and energetic TPEs are reviewed. Biodegradable and hydrolyzable binders are discussed. The applicability of various types of explosive formulations are reviewed and some issues associated with implementation of recyclable formulations are identified. It is clear that some processing and weaponization modifications will need to be made if any of these approaches are to be implemented. The major advantages of formulations suggested here over PBXN-109 and M-43 is their reuse/recyclability. Formulations using TPE or Paste could by recovered from a generic bomb or propellant and reused if they met specification or easily reprocessed and sold to the mining industry.

30596 (UCRL-JC–120138) **Shock initiation of an ϵ-CL-20-estane formulation.** Tarver, C.M.; Simpson, R.L.; Urtiew, P.A. Lawrence Livermore National Lab., CA (United States). 19 Jul 1995. 8p. Sponsored by USDOE, Washington, DC (United States). DOE Contract W-7405-ENG-48. (CONF-950846–42: American Physical Society biennial conference on shock compression of condensed matter, Seattle, WA (United States), 13-18 Aug 1995). Order Number DE95017814. Source: OSTI; NTIS; GPO Dep.

The shock sensitivity of a pressed solid explosive formulation, LX-19, containing 95.2% by weight epsilon phase 2,4,6,8,10,12-hexanitrohexaazaisowurtzitane (HNIW) and 4.8% Estane binder, was determined using the wedge test and embedded manganin pressure gauge techniques. This formulation was shown to be slightly more sensitive than LX-14, which contains 95.5% HMX and 4.5% Estane binder. The measured pressure histories for LX-19 were very similar to those obtained using several HMX-inert binder formulations. An Ignition and Growth reactive model for LX-19 was developed which differed from those for HMX-inert binder formulations only by a 25% higher hot spot growth rate.

30597 (UCRL-JC–120139) **Shock initiation of 1,3,3-trinitroazetidine (TNAZ).** Simpson, R.L.; Urtiew, P.A.; Tarver, C.M. Lawrence Livermore National Lab., CA (United States). 19 Jul 1995. 6p. Sponsored by USDOE, Washington, DC (United States). DOE Contract W-7405-ENG-48. (CONF-950846–53: American Physical Society biennial conference on shock compression of condensed matter, Seattle, WA (United States), 13-18 Aug 1995). Order Number DE95017874. Source: OSTI; NTIS; GPO Dep.

The shock sensitivity of the pressed solid explosive 1,3,3-trinitroazetidine (TNAZ) was determined using the embedded manganin pressure gauge technique. At an initial pressure of 1.3 GPa, pressure buildup (exothermic reaction) was observed after ten μs. At 2 GPa, TNAZ reacted rapidly and transitioned to detonation in approximately 13 mm. At 3.6 GPa, detonation occurred in less than 6 mm of shock propagation. Thus, pure TNAZ is more shock sensitive than HMX-based explosives but less shock sensitive than PETN-based explosives. The shocked TNAZ exhibited little reaction directly behind the shock front, followed by an extremely rapid reaction. This reaction caused both a detonation wave and a retonation wave in the partially decomposed TNAZ. An Ignition and Growth reactive model for TNAZ was developed to help understand this complex initiation phenomenon.

30598 (UCRL-JC–120140) **Shock initiation of 2,4-dinitroimidazole (2,4-DNI).** Urtiew, P.A.; Tarver, C.M.; Simpson, R.L. Lawrence Livermore National Lab., CA (United States). 19 Jul 1995. 6p. Sponsored by USDOE, Washington, DC (United States). DOE Contract W-7405-ENG-48. (CONF-950846–52: American Physical Society biennial conference on shock compression of condensed matter, Seattle, WA (United States), 13-18 Aug 1995). Order Number DE95017876. Source: OSTI; NTIS; GPO Dep.

The shock sensitivity of the pressed solid explosive 2,4-dinitroimidazole (2,4-DNI) was determined using the embedded manganin pressure gauge technique. At an initial shock pressure of 2 GPa, several microseconds were required before any exothermic reaction was observed. At 4 GPa, 2,4-DNI reacted more rapidly but did not transition to detonation at the 12 mm deep gauge position. At 6 GPa, detonation occurred in less than 6 mm of shock propagation. Thus, 2,4-DNI is more shock sensitive than TATB-based explosives but is considerably less shock sensitive than HMX-based explosives. An Ignition and Growth reactive flow model for 2,4-DNI based on these gauge records showed that 2,4-DNI exhibits shock initiation characteristics similar to TATB but reacts faster. The chemical structure of 2,4-DNI suggests that it may exhibit thermal decomposition reactions similar to nitroguanine and explosives with similar ring structures, such as ANTA and NTO.

30599 (UCRL-JC–121439) **Reactive flow model development for PBXW-126 using modern nonlinear optimization methods.** Murphy, M.J. (and others); Simpson, R.L.; Urtiew, P.A. Lawrence Livermore National Lab., CA (United States). Aug 1995. 6p. Sponsored by Department of Defense, Washington, DC (United States). DOE Contract W-7405-ENG-48. (CONF-950846–43: American Physical Society biennial conference on shock compression of condensed matter, Seattle, WA (United States), 13-18 Aug 1995). Order Number DE96000348. Source: OSTI; NTIS; GPO Dep.

The initiation and detonation behavior of PBXW-126 has been characterized and is described. PBXW-126 is a composite explosive consisting of approximately equal amounts of RDX, AP, AL, and NTO with a polyurethane binder. The three term ignition and growth of reaction model parameters (ignition + two growth terms) have been found using nonlinear optimization methods to determine the "best" set of model parameters. The ignition term treats the initiation of up to 0.5% of the RDX The first growth term in the model treats the RDX growth of reaction up to 20% reacted. The second growth term treats the subsequent growth of reaction of the remaining AP/AL/NTO. The unreacted equation of state (EOS) was determined from the wave profiles of embedded gauge tests while the JWL product EOS was determined from cylinder expansion test results. The nonlinear optimization code, NLQPEB/GLO, was used to determine the "best" set of coefficients for the three term Lee-Tarver ignition and growth of reaction model.

30600 (UCRL-JC–121891) **Time-resolved temperatures of shocked and detonating energetic materials.** Yoo, C.S.; Holmes, N.C.; Souers, P.C. Lawrence Livermore National Lab., CA (United States). 14 Aug 1995. 6p. Sponsored by USDOE, Washington, DC (United States). DOE Contract W-7405-ENG-48. (CONF-950846–63: American Physical Society biennial conference on shock compression of condensed matter, Seattle, WA (United States), 13-18 Aug 1995). Order Number DE96000382. Source: OSTI; NTIS; GPO Dep.

Chemical processes occurring in shock-compressed and detonating high explosives have been studied using fast time-resolved emission spectroscopy and a two-stage gas-gun. The spectral characteristics of emission from shock-compressed nitromethane, tetranitromethane and single crystals of pentaerythritol tetranitrate are typically very broad and structureless, likely representing thermal emission. Assuming the thermal emission from a gray-body, the emission intensity can be correlated to the temperature changes in shock-compressed and detonating high explosives. The authors report Chapman-Jouguet temperatures of 3,800 K for nitromethane, 2,950 K for tetranitromethane, and 4,100 K for pentaerythritol tetranitrate. In this paper the authors also compare the data with the chemical equilibrium models.

30601 (UCRL-JC–122096) **Freeze-out of carbon monoxide in calorimetry tests.** Ree, F.H. (and others); Pitz, W.J.; Thiel, M. van. Lawrence Livermore National Lab., CA (United States). 22 Aug 1995. 3p. Sponsored by USDOE, Washington, DC (United States). DOE Contract W-7405-ENG-48. (CONF-9509226–1: 15. Association for the International Advancement of High Pressure & Technology international conference, Warsaw (Poland), 11-15 Sep 1995). Order Number DE96000392. Source: OSTI; NTIS; GPO Dep.

The amount of carbon monoxide recovered from calorimetry tests of high explosives is far larger than the amount predicted by equilibrium calculations. The present analysis shows that chemical reactions which produce CH_4 are the most important ones to lead to equilibrium below 1000 K but are effectively blocked by a rapid cooling of the calorimetric bomb. Furthermore, reaction $CO + H_2O \rightarrow H_2 + CO_2$, which is the key reaction at $T > 1000$ K slows down at lower temperatures. The observed overabundance of CO is a direct consequence of both factors.

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Refer also to citation(s) 29128, 29145, 29149, 29981, 29985, 29986, 30321, 30417, 30626, 30642, 30701, 30702, 31241

30602 (LA–12988-MS) **RADFLO physics and algorithms.** Symbalisty, E.M.D.; Zinn, J.; Whitaker, R.W. Los Alamos National Lab., NM (United States). Sep 1995. 53p. Sponsored by USDOE, Washington, DC (United States). DOE Contract W-7405-ENG-36. Order Number DE96000892. Source: OSTI; NTIS; GPO Dep.

This paper describes the history, physics, and algorithms of the computer code RADFLO and its extension HYCHEM. RADFLO is a one-dimensional, radiation-transport hydrodynamics code that is used to compute early-time fireball behavior for low-altitude nuclear bursts. The primary use of the code is the prediction of optical signals produced by nuclear explosions. It has also been used to predict thermal and hydrodynamic effects that are used for vulnerability and lethality applications. Another closely related code, HYCHEM, is an extension of RADFLO which includes the effects of nonequilibrium chemistry. Some examples of numerical results will be shown, along with scaling expressions derived from those results. We describe new computations of the structures and luminosities of steady-state shock waves and radiative thermal waves, which have been extended to cover a range of ambient air densities for high-altitude applications. We also describe recent modifications of the codes to use a one-dimensional analog of the CAVEAT fluid-dynamics algorithm in place of the former standard Richtmyer-von Neumann algorithm.

30603 (LA–13027-M) **LACHESIS – An instrumentation system for obtaining containment and environmental data.** Deupree, R.G.; Oblad, F.R. Los Alamos National Lab., NM (United States). Sep 1995. 54p. Sponsored by USDOE, Washington, DC (United States). DOE Contract W-7405-ENG-36. Order Number DE96000054. Source: OSTI; NTIS; GPO Dep.

The instrumentation system developed to obtain containment and environmental data in the LYNER complex is presented. The primary purpose of this report is to familiarize potential operators of the system with the details of its use. The instrumentation system has three major hardware modules: (1) the sensor power source, amplifier, and signal conditioner module, (2) the digitizers, and (3) the computer controller. Each of these is described with emphasis on the steps required to make that component perform effectively. In addition the roles of activities of other people besides the Los Alamos shot engineer who are required to ensure the success of the system are outlined.

30604 (LA-SUB–93-143) **Opto-mechanical design and fabrication services. Final report.** Los Alamos National Lab., NM (United States); Optomec Design Co., Los Alamos, NM (United States). 28 Feb 1988. 7p. Sponsored by USDOE, Washington, DC (United States);Department of Defense, Washington, DC (United States). DOE Contract W-7405-ENG-36. Subcontract 9-X16-9740D-1. Order Number DE96000173. Source: OSTI; NTIS; GPO Dep.

Each of the seven tasks defined under this contract are discussed here. They include: (1) design support for an x-ray spectrometer for the "Panchuela" down-hole experiment at the Nevada Test Site; (2) development and demonstration of an optical alignment method for aligning the 180 degree bend achromatic

magnetic section of the Ground Test Accelerator; (3) development of magnet support and manipulation concepts for the 17 magnets of the Ground Test Accelerator; (4) design support for the triplett magnet telescope assembly and its support structure (Neutral Particle Beam Program); (5) design and support for the beam diagnostic system for the Argonne Particle Beam experiment; (6) conceptual design for the modification of an Antares Marx tank for use in the Aurora Laser Program; and (7) design of poloidal gap for the Los Alamos ZTH reversed-field pinch machine.

30605 (LBL–31248-Rev.) **Heavy ion driven LMF design concept. Revised.** Lee, E.P. Lawrence Berkeley Lab., CA (United States). Jul 1995. 48p. Sponsored by USDOE, Washington, DC (United States). DOE Contract AC03-76SF00098. Order Number DE96001004. Source: OSTI; NTIS; GPO Dep.

From 1988 to 1991, the US Department of Energy conducted a study of the requirements, designs and costs for a Laboratory Microfusion Facility (LMF). The primary purpose of the LMF would be testing of weapons physics and effects simulation using the output from microexplosions of inertial fusion targets. It does not need a high repetition rate, efficient driver system as required by an electrical generating plant; however there would be so many features in common that the design, construction and operation of an LMF would considerably advance the application of inertial confinement fusion to energy production. The DOE study concentrated particularly on the LMF driver, with design and component development undertaken at several national laboratories. Heavy Ions, although considered a possible LMF driver, did not receive attention until the final stages of this study since its program management was through the Office of Energy Research rather than Defense Programs. However, during preparation of the summary report for the study it was decided that an account of heavy ions was needed for a complete survey of the driver candidates. The conceptual heavy ion LMF driver design created for the DOE report did not receive the level of scrutiny of the other driver concepts and, unlike the others, no cost analysis by an independent contractor was performed.

30606 (MLM–98) **Control Section progress report, April 1–30, 1948.** Rembold, E.A. Monsanto Chemical Co., Dayton, OH (United States). [1948]. 7p. Sponsored by USDOE, Washington, DC (United States). DOE Contract AC24-88DP43495. Order Number DE96001499. Source: OSTI; NTIS; GPO Dep.

From the Assay group, information is given for production concerning routine assaying, calorimetry, and neutron detection, unit 5, and future plans. The Micro-Assay group reports on production, development, research, units 5 & 6, and future plans. The Inventory group gives a report on production relating to alpha and DM slides, development of hoods,poppy counters and safe barriers, research, and future plans. Control Section Administration also reports on production of neutron counters, development of the Logac-L chamber, research, and unit 5.

30607 (MLM–131) **Gamma scale chemistry progress report.** Economides, M. (and others); Estabrook, E.; Joy, E.F. Mound, Miamisburg, OH (United States). Jun 1948. 18p. Sponsored by USDOE, Washington, DC (United States). DOE Contract AC24-88DP43495. Order Number DE96001471. Source: OSTI; NTIS; GPO Dep.

This report considers the work done during the year ending June 30, 1948, present work being done and future plans on the determination of formulas, methods of preparation, and properties of as many compounds of postum as possible. An experimental approach to such a research problem on the element postum requires that procedures which may be used deal with ultramicro quantities of material. Such procedures on an ultramicro or gamma scale require special techniques by personnel trained in manipulating these small quantities of radioactive material. Equipment which may be used varies with the experiment considered. Often new apparatus must be developed or equipment previously developed and used in some other experiment must be modified. This generalized research problem is subdivided in the "Research Problems Outline". The presentation of a survey of these research problems with reference to the outline for the year ending June 30, 1948 is a critical review of the work done by the Gamma Scale Chemistry Group as well as a consideration of future plans. The course which these future plans may follow will depend upon information which may be obtained when carrying out planned experiments.

30608 (MLM–132) **Physics progress report.** Brocklehurst, R.E (and others); Brooks, L.S.; Davenport, T.I. Mound, Miamisburg, OH (United States). Jun 1948. 16p. Sponsored by USDOE, Washington, DC (United States). DOE Contract AC24-88DP43495. Order Number DE96001472. Source: OSTI; NTIS; GPO Dep.

This document is a de-classified June 1948 Physics Group Progress Report from Monsanto Chemical's Mound facility. Areas discussed include: (1) neutronics, (2) resistivity of Postum, (3) purity of Postum, (4) vapor pressure of Selenium and Postum, and (5) x-ray laboratory efforts.

30609 (MLM–133) **General chemistry progress report.** Barth, S. (and others); Ford, M.; Dismore, P. Mound, Miamisburg, OH (United States). Jun 1948. 24p. Sponsored by USDOE, Washington, DC (United States). DOE Contract AC24-88DP43495. Order Number DE96001473. Source: OSTI; NTIS; GPO Dep.

Decomposition potentials of bismuth solutions of 1.037 and 0.509 grams of the metal per 100 ml. of 1.5 nitric acid were found to be -0.06 and -0.09 volts to N.C.E. These results confirm previous values and indicate that bismuth will not be reduced from production solutions at the potential of the normal calomel electrode. A summary of research in progress, completed, or anticipated is given.

30610 (MLM–138) **Electrodeposition research progress report.** Abel, W. (and others); Bell, R.; Neibel, C. Mound, Miamisburg, OH (United States). Jun 1948. 17p. Sponsored by USDOE, Washington, DC (United States). DOE Contract AC24-88DP43495. Order Number DE96001474. Source: OSTI; NTIS; GPO Dep.

This report contains a review of this work conducted by the Electrodeposition Group for the last six months. Pictures and a discussion of the method used to convert production solutions to postum to hydrofluoride acid solutions of postum are given. Attempts to plate postum in an inert atmosphere by remote control have been made. As yet no successful runs have been completed. Standardization of normal calomel electrodes by comparison to silver-silver chloride electrodes and to hydrogen electrodes is described.

30611 (MLM–155) **General chemistry progress report.** Barth, S. (and others); Ford, M.; Dismore, P. Mound, Miamisburg, OH (United States). Jul 1948. 14p. Sponsored by USDOE, Washington, DC (United States). DOE Contract AC24-88DP43495. Order Number DE96001476. Source: OSTI; NTIS; GPO Dep.

This document is a de-classified July 1948 General Chemistry Progress Report from Monsanto Chemical's Mound facility. Detailed discussions of numerous studies of Postum compounds are included in this report, and experimental data on various chemical and physical properties of these compounds are given.

30612 (MLM–159) **Process research progress report.** Hamilton, P. (and others); Huddleston, F.; Mead, F. Mound, Miamisburg, OH (United States). Jul 1948. 11p. Sponsored by USDOE, Washington, DC (United States). DOE Contract AC24-88DP43495. Order Number DE96001477. Source: OSTI; NTIS; GPO Dep.

This document is a declassified July 1948 Progress Report on Process Research at Monsanto Chemical's Mound facility. Areas discussed are: (1) treatment of hot solid wastes, and (2) treatment of hot liquid wastes. Chemical aspects of these processes are noted.

30613 (MLM–176) **General chemistry progress report.** Barth, S. (and others); Ford, M.; Dismore, P. Mound, Miamisburg, OH (United States). Aug 1948. 10p. Sponsored by USDOE, Washington, DC (United States). DOE Contract AC24-88DP43495. Order Number DE96001479. Source: OSTI; NTIS; GPO Dep.

This document is a de-classified August 1948 General Chemistry progress report from Monsanto Chemical's Mound facility. General chemical properties of Postum compounds are discussed, and experimental data on these properties are presented.

30614 (MLM–218) **Laboratory instrument design progress report, October 1–31, 1948.** Olt, R.G. Mound Lab., Miamisburg,

OH (United States). [1948]. 4p. Sponsored by USDOE, Washington, DC (United States). DOE Contract AC04-76DP00053. Order Number DE96001398. Source: OSTI; NTIS; GPO Dep.

Progress reports are given for three projects: Number 1-C quartz- fiber microbalance construction and maintenance, Number 9 design of multiple stirrer plating unit, and Number 10 design of rotating stage for foil photography.

30615 (SAND–95-2053) **Characteristics and development report for the SA3871 Intent Controller application specific integrated circuit (ASIC).** Simpson, R.L.; Meyer, B.T. Sandia National Labs., Albuquerque, NM (United States). Aug 1995. 51p. Sponsored by USDOE, Washington, DC (United States). DOE Contract AC04-94AL85000. Order Number DE96000703. Source: OSTI; NTIS; GPO Dep.

This report describes the design and development activities that were involved in the SA3871 Intent Controller ASIC. The SA3871 is a digital gate array component developed for the MC4396 Trajectory Sensing Signal Generator for use in the B61-3/4/10 system as well as a possible future B61-MAST system.

30616 (UCRL-ID–119189) **Using an intelligent nuclear sensor in the "Cooperative Corral" scenario.** Rumble, R.P. Lawrence Livermore National Lab., CA (United States). Apr 1995. 22p. Sponsored by USDOE, Washington, DC (United States). DOE Contract W-7405-ENG-48. Order Number DE95017716. Source: OSTI; NTIS (US Sales Only); GPO Dep.

The "Cooperative Corral" scenario using the Intelligent Nuclear Sensor is described. The term "cooperative corral" was coined to describe the scenario in which a number of nuclear weapons are kept in one place (the "corral"). The owners of the weapons cooperate with the monitoring party. The monitoring party surrounds, but does not enter, the corral. In this scenario, the Intelligent Nuclear Sensor monitors vehicles leaving the corral to determine if they are carrying significant fractions of the amount of plutonium needed to make a nuclear weapon. Test results are given that show that the Intelligent Nuclear Sensor performs this mission well.

30617 (UCRL-ID–122069) **AKAVI containment data report.** Stubbs, T.; Heinle, R. Lawrence Livermore National Lab., CA (United States). Aug 1995. 59p. Sponsored by USDOE, Washington, DC (United States). DOE Contract W-7405-ENG-48. Order Number DE96000332. Source: OSTI; NTIS; INIS; GPO Dep.

The AKAVI event was detonated in hole U2es of the Nevada Test Site as indicated. The device had a depth-of-burial (DOB) of 494 m in the Paintbrush Tuff of area 2, about 90 m above the standing water level and 300 m above the Paleozoic formation. Stemming of the 2.44 m diameter emplacement hole followed the plan. A log of the stemming operations was maintained by Holmes & Narver. Detonation time was 07:00 PST on December 3, 1981 and 103 minutes later a surface collapse occurred leaving a crater with mean radius of 90.5 m and maximum depth of 19.5 m. No radiation arrivals were detected above ground and the AKAVI containment was considered successful.

4503 Nuclear Explosion Detection

Refer also to citation(s) 30550, 30617, 30852, 30853, 31381

30618 (SAND–95-1831C) **WCEDS: A waveform correlation event detection system.** Young, C.J. (Sandia National Labs., Albuquerque, NM (United States)); Beiriger, J.I.; Trujillo, J.R.; Withers, M.M.; Aster, R.C.; Astiz, L.; Shearer, P.M. Sandia National Labs., Albuquerque, NM (United States). [1995]. 11p. Sponsored by USDOE, Washington, DC (United States). DOE Contract AC04-94AL85000. (CONF-950954–2: 17. annual electrical overstress/electrostatic discharge symposium, Phoenix, AZ (United States), 11-14 Sep 1995). Order Number DE95016760. Source: OSTI; NTIS; GPO Dep.

We have developed a working prototype of a grid-based global event detection system based on waveform correlation. The algorithm comes from a long-period detector but we have recast it in a full matrix formulation which can reduce the number of multiplications needed by better than two orders of magnitude for realistic monitoring scenarios. The reduction is made possible by eliminating redundant multiplications in the original formulation. All unique correlations for a given origin time are stored in a correlation matrix (C) which is formed by a full matrix product of a Master Image matrix (M) and a data matrix (D). The detector value at each grid point is calculated by following a different summation path through the correlation matrix. Master Images can be derived either empirically or synthetically. Our testing has used synthetic Master Images because their influence on the detector is easier to understand. We tested the system using the matrix formulation with continuous data from the IRIS (Incorporate Research Institutes for Seismology) broadband global network to monitor a 2 degree evenly spaced surface grid with a time discretization of 1 sps; we successfully detected the largest event in a two hour segment from October 1993. The output at the correct gridpoint was at least 33% larger than at adjacent grid points, and the output at the correct gridpoint at the correct origin time was more than 500% larger than the output at the same gridpoint immediately before or after. Analysis of the C matrix for the origin time of the event demonstrates that there are many significant "false" correlations of observed phases with incorrect predicted phases. These false correlations dull the sensitivity of the detector and so must be dealt with if our system is to attain detection thresholds consistent with a Comprehensive Test Ban Treaty (CTBT).

30619 (UCRL-CR–121206) **Establishment of data base of regional seismic recordings from earthquakes, chemical explosions and nuclear explosions in the Former Soviet Union.** Ermolenko, N.A. (AN SSSR, Moscow (Russian Federation). Inst. Fiziki Zemli); Kopnichev, Yu.F.; Kunakov, V.G.; Kunakova, O.K.; Rakhmatullin, M.Kh.; Sokolova, I.N.; Vybornyy, Zh.I. Lawrence Livermore National Lab., CA (United States); AN SSSR, Moscow (Russian Federation). Inst. Fiziki Zemli. Jun 1995. 110p. Sponsored by USDOE, Washington, DC (United States). DOE Contract W-7405-ENG-48. Order Number DE95015410. Source: OSTI; NTIS; GPO Dep.

In this report results of work on establishment of a data base of regional seismic recordings from earthquakes, chemical explosions and nuclear explosions in the former Soviet Union are described. This work was carried out in the Complex Seismological Expedition (CSE) of the Joint Institute of Physics of the Earth of the Russian Academy of Sciences and Lawrence Livermore National Laboratory. The recording system, methods of investigations and primary data processing are described in detail. The largest number of digital records was received by the permanent seismic station Talgar, situated in the northern Tien Shan, 20 km to the east of Almaty city. More than half of the records are seismograms of underground nuclear explosions and chemical explosions. The nuclear explosions were recorded mainly from the Semipalatinsk test site. In addition, records of the explosions from the Chinese test site Lop Nor and industrial nuclear explosions from the West Siberia region were obtained. Four records of strong chemical explosions were picked out (two of them have been produced at the Semipalatinsk test site and two – in Uzbekistan). We also obtained 16 records of crustal earthquakes, mainly from the Altai region, close to the Semipalatinsk test site, and also from the West China region, close to the Lop Nor test site. In addition, a small number of records of earthquakes and underground nuclear explosions, received by arrays of temporary stations, that have been working in the southern Kazakhstan region are included in this report. Parameters of the digital seismograms and file structure are described. Possible directions of future work on the digitizing of unique data archive are discussed.

30620 (UCRL-CR–121900) **Investigations into seismic discrimination between earthquakes, chemical explosions and nuclear explosions.** Kopnichev, Y.F. (and others); Aptikaev, F.F.; Antonova, L.V. Lawrence Livermore National Lab., CA (United States). Aug 1995. 227p. Sponsored by USDOE, Washington, DC (United States). DOE Contract W-7405-ENG-48. Order Number DE95017844. Source: OSTI; NTIS; GPO Dep.

In this report we describe some results of investigations on a problem of discrimination between nuclear explosions, chemical explosions and earthquakes, carried out in the Complex Seismological Expedition of the Joint Institute of Physics of the Earth of the Russian Academy of Sciences. Records of underground nuclear explosions from the Semipalatinsk test site, and from region the Pre-Caspian depression, and also records of nearby chemical

explosions and earthquakes were processed. We analysed records of permanent and temporary stations, located mainly in the North Tien Shan, northern Kazakhstan and Urals regions. We studied the influence of regional conditions on the effectiveness of seismic monitoring of nuclear explosions. Various amplitude criteria of the discrimination between explosions and earthquakes are considered. We analyzed possibilities to discriminate different source types using spectral-temporal characteristics of seismograms. The nature of some wave types, recorded at region distances, is investigated. We consider possibilities of discrimination between nuclear and chemical explosions and earthquakes using analysis of characteristics of irregular waves. We outline future investigations, connected with the study of the unique set of seismograms kept in the CSE.

30621 (UCRL-ID–122067) **Low frequency electromagnetic signals from underground explosions: On-site inspections research progress report.** Sweeney, J.J. Lawrence Livermore National Lab., CA (United States). 21 Jul 1995. 22p. Sponsored by USDOE, Washington, DC (United States). DOE Contract W-7405-ENG-48. Order Number DE96000423. Source: OSTI; NTIS; GPO Dep.

We are investigating the characteristics of extremely low frequency (ELF) electromagnetic pulse (EMW) phenomena from underground nuclear and chemical explosions and from surface chemical explosions as they may be applied in an On-Site Inspection (OSI) context under a Comprehensive Test-Ban Treaty (CTBT). The principal application of these phenomena is for discrimination among underground chemical explosions, underground nuclear explosions, and earthquakes. Underground chemical and nuclear explosions both generate low-frequency EMP signals (about 1 Hz) that are observable within several kilometers of ground zero. During this fiscal year we have been gathering data from explosions of opportunity to see if ELF EMP signals are observable from large ripple-fired blasts and from smaller dedicated explosions such as those occurring at the NTS. In addition, we are continuing to review data from the Henderson Mine deployment that took place during FY94 and data from previous underground nuclear tests including Hunter's Trophy and past underground nuclear tests have been analyzed and we here make estimates of the properties of the EMP ftom underground nuclear ard chemical explosions, including detectability, dependence on yield, and dependence on distance from the source. Data from the Henderson Mine provide information about detection of EMP from typical moderate size underground chemical explosions in hard rock and problems related to detection of EMP in a mine environment located at high elevations. Data from the Carlin Mine site provide information about EMP from surface ripple-fired chemical explosions and detection in an open-pit mine environment. Data from the Kuchen experiment at NTS provide additional data about small underground chemical explosions in a setting similar to that for underground nuclear tests at the NTS.

4505 Strategic Defense Initiative

Refer also to citation(s) 30604

30622 (LA-SUB–93-156) **Opto-mechanical support services. Final report.** Los Alamos National Lab., NM (United States); Optomec Design Co., Los Alamos, NM (United States). 11 Jun 1990. 3p. Sponsored by Department of Defense, Washington, DC (United States). DOE Contract W-7405-ENG-36. Subcontract 9-XT8-8701U-1. Order Number DE96000174. Source: OSTI; NTIS; GPO Dep.

This subcontract was for Optomec'c support of the Los Alamos National Laboratory's (LANL's) Group MEE-12 in the technical specialty area of opto-mechanical design, engineering and fabrication. Two individual tasks were defined by MEE-12 and completed by Optomec personnel. Edward J. Yavornik acted as Principal Investigator on the Wire and Fluorescent Fiber Offset Grid (WAFFOG) for the Neutral Particle Beam (NPB) GTA (Ground Test Accelerator) Experiment, and Thomas Swann acted as Principal Investigator on the ESS-7 Photometers Project. Some hardware was procured/fabricated for the ESS-7 Photometer task, however, most of the work consisted of design and engineering support resulting in drawings and specifications which were prepared by MEE-12 personnel. There were no technical papers or patents generated by Optomec personnel as a result of this work, and all work defined in the contract was completed.

30623 (LA-SUB–95-109) **LANL High-Level Model (HLM) database development letter report.** Los Alamos National Lab., NM (United States); BDM Federal, Inc., Albuquerque, NM (United States). [1995]. 80p. Sponsored by Department of Defense, Washington, DC (United States). DOE Contract W-7405-ENG-36. 1598F0013-95. Order Number DE96000861. Source: OSTI; NTIS; GPO Dep.

Traditional methods of evaluating munitions have been able to successfully compare like munition's capabilities. On the modern battlefield, however, many different types of munitions compete for the same set of targets. Assessing the overall stockpile capability and proper mix of these weapons is not a simple task, as their use depends upon the specific geographic region of the world, the threat capabilities, the tactics and operational strategy used by both the US and Threat commanders, and of course the type and quantity of munitions available to the CINC. To sort out these types of issues, a hierarchical set of dynamic, two-sided combat simulations are generally used. The DoD has numerous suitable models for this purpose, but rarely are the models focused on munitions expenditures. Rather, they are designed to perform overall platform assessments and force mix evaluations. However, in some cases, the models could be easily adapted to provide this information, since it is resident in the model's database. Unfortunately, these simulations' complexity (their greatest strength) precludes quick turnaround assessments of the type and scope required by senior decision-makers.

30624 (UCRL-JC–119387) **Double pulse experiment with a velvet cathode on the ATA injector.** Westenskow, G.; Caporaso, G.; Chen, Y.; Houck, T.; Sampayan, S. Lawrence Livermore National Lab., CA (United States). 24 Apr 1995. 6p. Sponsored by USDOE, Washington, DC (United States). DOE Contract W-7405-ENG-48. (CONF-950512–333: Particle accelerator conference, Dallas, TX (United States), 1-5 May 1995). Order Number DE96000380. Source: OSTI; NTIS; GPO Dep.

Double pulse transport experiments were conducted on the front end of the ATA accelerator to obtain data on the capability of a velvet cloth cathode to produce two successive pulses. Pulses of approximately 3 kA were extracted from the cathode with interpulse spacings varying from 150 ns to 2.8 μs using an anode-cathode voltage of about 1 MV. Analysis of the current and voltage waveform data from the injector indicate that the effects of cathode plasma on the second pulse of a two-pulse burst is minimal.

4506 Chemical and Biological

30625 (ORNL–6764) **Planning guidance for the Chemical Stockpile Emergency Preparedness Program.** Shumpert, B.L. (and others); Watson, A.P.; Sorensen, J.H. Oak Ridge National Lab., TN (United States). Feb 1995. 300p. Sponsored by Department of Defense, Washington, DC (United States);Federal Emergency Management Agency, Washington, DC (United States). DOE Contract AC05-84OR21400. Order Number DE96000884. Source: OSTI; NTIS; GPO Dep.

This planning guide was developed under the direction of the U.S. Army and the Federal Emergency Management Agency (FEMA) which jointly coordinate and direct the development of the Chemical Stockpile Emergency Preparedness Program (CSEPP). It was produced to assist state, local, and Army installation planners in formulating and coordinating plans for chemical events that may occur at the chemical agent stockpile storage locations in the continental United States. This document provides broad planning guidance for use by both on-post and off-post agencies and organizations in the development of a coordinated plan for responding to chemical events. It contains checklists to assist in assuring that all important aspects are included in the plans and procedures developed at each Chemical Stockpile Disposal Program (CSDP) location. The checklists are supplemented by planning guidelines in the appendices which provide more detailed guidance regarding some issues. The planning guidance contained in this document will help ensure that adequate coordination between on-post and off-post planners occurs during the planning process. This planning

guide broadly describes an adequate emergency planning base that assures that critical planning decisions will be made consistently at every chemical agent stockpile location. This planning guide includes material drawn from other documents developed by the FEMA, the Army, and other federal agencies with emergency preparedness program responsibilities. Some of this material has been developed specifically to meet the unique requirements of the CSEPP. In addition to this guidance, other location-specific documents, technical studies, and support studies should be used as needed to assist in the planning at each of the chemical agent stockpile locations to address the specific hazards and conditions at each location.

30626 (UCRL-ID–120854) **Effects of kinetic energy shielding on energy deposition in a biological submunition warhead by low-yield nuclear interceptors.** Mendelsohn, E. Lawrence Livermore National Lab., CA (United States). Dec 1994. 13p. Sponsored by USDOE, Washington, DC (United States). DOE Contract W-7405-ENG-48. Order Number DE96001052. Source: OSTI; NTIS (US Sales Only); GPO Dep.

The authors have continued a series of Monte Carlo coupled neutron/photon calculations in which they have simulated a low-yield nuclear interceptor attacking a biological submunition warhead. In the course of this series a variety of changes were introduced. In the present case, they have modified the original submunition warhead model, which contained 42 canisters, retaining only four central canisters, and using the vacated space for shielding against attack by fragment or hit-to-kill interceptors. They are presenting the results of these calculations and compare them to a previously obtained baseline calculation. They find that a 100 ton fission warhead will neutralize the biological agent fill of all four shielded submunition canisters by radiation sterilization at a distance of about three meters.

54 ENVIRONMENTAL SCIENCES

Refer also to citation(s) 28822, 28890, 28971, 28991, 29107, 29847, 29855

30627 (DOE/AL/62350–95-Rev.1) **UMTRA Project water sampling and analysis plan, Canonsburg, Pennsylvania. Revision 1.** Jacobs Engineering Group, Inc., Albuquerque, NM (United States). Sep 1995. 30p. Sponsored by USDOE, Washington, DC (United States). DOE Contract AC04-91AL62350. Order Number DE96000656. Source: OSTI; NTIS; INIS; GPO Dep.

Surface remedial action was completed at the US Department of Energy (DOE) Canonsburg and Burrell Uranium Mill Tailings Remedial Action (UMTRA) Project sites in southwestern Pennsylvania in 1985 and 1987, respectively. The Burrell disposal site, included in the UMTRA Project as a vicinity property, was remediated in conjunction with the remedial action at Canonsburg. On 27 May 1994, the Nuclear Regulatory Commission (NRC) accepted the DOE final Long-Term Surveillance Plan (LTSP) (DOE, 1993) for Burrell thus establishing the site under the general license in 10 CFR §40.27 (1994). In accordance with the DOE guidance document for long-term surveillance (DOE, 1995), all NRC/DOE interaction on the Burrell site's long-term care now is conducted with the DOE Grand Junction Projects Office in Grand Junction, Colorado, and is no longer the responsibility of the DOE UMTRA Project Team in Albuquerque, New Mexico. Therefore, the planned sampling activities described in this water sampling and analysis plan (WSAP) are limited to the Canonsburg site. This WSAP identifies and justifies the sampling locations, analytical parameters, detection limits, and sampling frequencies for routine monitoring at the Canonsburg site for calendar years 1995 and 1996. Currently, the analytical data further the site characterization and demonstrate that the disposal cell's initial performance is in accordance with design requirements.

30628 (DOE/AL/62350–117S) **Supplement to the UMTRA Project water sampling and analysis plan, Riverton, Wyoming.** Jacobs Engineering Group, Inc., Albuquerque, NM (United States). Sep 1995. 5p. Sponsored by USDOE, Washington, DC (United States). DOE Contract AC04-91AL62350. Order Number DE96000658. Source: OSTI; NTIS; INIS; GPO Dep.

This water sampling and analysis plan (WSAP) supplement supports the regulatory and technical basis for water sampling at the Riverton, Wyoming, Uranium Mill Tailings Remedial Action (UMTRA) Project site, as defined in the 1994 WSAP document for Riverton (DOE, 1994). Further, the supplement serves to confirm the Project's present understanding of the site relative to the hydrogeology and contaminant distribution as well as the intent to continue to use the sampling strategy as presented in the 1994 WSAP document for Riverton. Ground water and surface water monitoring activities are derived from the US Environmental Protection Agency regulations in 40 CFR Part 192 and 60 FR 2854. Sampling procedures are guided by the UMTRA Project standard operating procedures (JEG, n.d.), the Technical Approach Document (DOE, 1989), and the most effective technical approach for the site. Additional site-specific documents relevant to the Riverton site are the Riverton Baseline Risk Assessment (BLRA) (DOE, 1995a) and the Riverton Site Observational Work Plan (SOWP) (DOE, 1995b).

30629 (DOE/AL/62350–125S) **Supplement to the UMTRA Project water sampling and analysis plan, Maybell, Colorado.** Jacobs Engineering Group, Inc., Albuquerque, NM (United States). Sep 1995. 5p. Sponsored by USDOE, Washington, DC (United States). DOE Contract AC04-91AL62350. Order Number DE96000659. Source: OSTI; NTIS; INIS; GPO Dep.

This water sampling and analysis plan (WSAP) supplement supports the regulatory and technical basis for water sampling at the Maybell, Colorado, Uranium Mill Tailings Remedial Action (UMTRA) Project site, as defined in the 1994 WSAP document for Maybell (DOE, 1994a). Further, this supplement serves to confirm our present understanding of the site relative to the hydrogeology and contaminant distribution as well as our intention to continue to use the sampling strategy as presented in the 1994 WSAP document for Maybell. Ground water and surface water monitoring activities are derived from the US Environmental Protection Agency regulations in 40 CFR Part 192 (1994) and 60 CFR 2854 (1 995). Sampling procedures are guided by the UMTRA Project standard operating procedures (JEG, n.d.), the Technical Approach Document (DOE, 1989), and the most effective technical approach for the site. Additional site-specific documents relevant to the Maybell site are the Maybell Baseline Risk Assessment (currently in progress), the Maybell Remedial Action Plan (RAP) (DOE, 1994b), and the Maybell Environmental Assessment (DOE, 1995).

30630 (DOE/AL/62350–146S) **Supplement to the UMTRA project water sampling and analysis plan, Slick Rock, Colorado.** Jacobs Engineering Group, Inc., Albuquerque, NM (United States). Sep 1995. 9p. Sponsored by USDOE, Washington, DC (United States). DOE Contract AC04-91AL62350. Order Number DE96000660. Source: OSTI; NTIS; INIS; GPO Dep.

The water sampling and analysis plan (WSAP) provides the regulatory and technical basis for ground water and surface water sampling at the Uranium Mill Tailings Remedial Action (UMTRA) Project Union Carbide (UC) and North Continent (NC) processing sites and the Burro Canyon disposal site near Slick Rock, Colorado. The initial WSAP was finalized in August 1994 and will be completely revised in accordance with the WSAP guidance document (DOE, 1995) in late 1996. This version supplements the initial WSAP, reflects only minor changes in sampling that occurred in 1995, covers sampling scheduled for early 1996, and provides a preliminary projection of the next 5 years of sampling and monitoring activities. Once surface remedial action is completed at the former processing sites, additional and more detailed hydrogeologic characterization may be needed to develop the Ground Water Program conceptual ground water model and proposed compliance strategy. In addition, background ground water quality needs to be clearly defined to ensure that the baseline risk assessment accurately estimated risks from the contaminants of potential concern in contaminated ground water at the UC and NC sites.

30631 (DOE/EW/50625–T25) **Summer Undergraduate Research Program: Environmental studies.** McMillan, J. (ed.). Medical Univ. of South Carolina, Charleston, SC (United States). 1994. 127p. Sponsored by USDOE, Washington, DC (United States). DOE Contract FG01-92EW50625. Order Number DE95016555. Source: OSTI; NTIS; GPO Dep.

The purpose of the summer undergraduate internship program for research in environmental studies is to provide an opportunity for well-qualified students to undertake an original research project as an apprentice to an active research scientist in basic environmental research. The students are offered research topics at the Medical University in the scientific areas of pharmacology and toxicology, epidemiology and risk assessment, environmental microbiology, and marine sciences. Students are also afforded the opportunity to work with faculty at the University of Charleston, SC, on projects with an environmental theme. Ten well-qualified students from colleges and universities throughout the eastern United States were accepted into the program.

30632 (EGG–11265-1118) **Secondary plant succession on disturbed sites at Yucca Mountain, Nevada.** Angerer, J.P.; Ostler, W.K.; Gabbert, W.D.; Schultz, B.W. EG and G Energy Measurements, Inc., Las Vegas, NV (United States). Dec 1994. 74p. Sponsored by USDOE, Washington, DC (United States). DOE Contract AC08-93NV11265. Order Number DE96000185. Source: OSTI; NTIS; INIS; GPO Dep.

This report presents the results of a study of secondary plant succession on disturbed sites created during initial site investigations in the late 1970s and early 1980s at Yucca Mountain, NV. Specific study objectives were to determine the rate and success of secondary plant succession, identify plant species found in disturbances that may be suitable for site-specific reclamation, and to identify environmental variables that influence succession on disturbed sites. During 1991 and 1992, fifty seven disturbed sites were located. Vegetation parameters, disturbance characteristics and environmental variables were measured at each site. Disturbed site vegetation parameters were compared to that of undisturbed sites to determine the status of disturbed site plant succession. Vegetation on disturbed sites, after an average of ten years, was different from undisturbed areas. Ambrosia dumosa, Chrysothamnus teretifolius, Hymenoclea salsola, Gutierrezia sarothrae, Atriplex confertifolia, Atriplex canescens, and Stephanomeria pauciflora were the most dominant species across all disturbed sites. With the exception of A. dumosa, these species were generally minor components of the undisturbed vegetation. Elevation, soil compaction, soil potassium, and amounts of sand and gravel in the soil were found to be significant environmental variables influencing the species composition and abundance of perennial plants on disturbed sites. The recovery rate for disturbed site secondary succession was estimated. Using a linear function (which would represent optimal conditions), the recovery rate for perennial plant cover, regardless of which species comprised the cover, was estimated to be 20 years. However, when a logarithmic function (which would represent probable conditions) was used, the recovery rate was estimated to be 845 years. Recommendations for future studies and site-specific reclamation of disturbances are presented.

30633 (EGG–11265-1125) **Lessons learned from FRMAC-93 exercise.** Kerns, K.C. EG and G Energy Measurements, Inc., Las Vegas, NV (United States). [1995]. 4p. Sponsored by USDOE, Washington, DC (United States). DOE Contract AC08-93NV11265. (CONF-950430–11: 5. ANS topical meeting on emergency preparedness and response, Savannah, GA (United States), 18-21 Apr 1995). Order Number DE96000159. Source: OSTI; NTIS; INIS; GPO Dep.

Short communication. ACCIDENTS/simulation; RADIOACTIVITY/environmental impacts; DRILLS; ACCIDENTS; SIMULATION; NEBRASKA; PLANNING; RADIOACTIVITY

30634 (INIS-mf–14556, pp. 8) **Radiation in Everyday Life.** Wahlstrom, B. (Head of Radiation Protection Imatran Voima Oy Loviisa NPS FIN-07900 Loviisa (Finland)). Atomic Energy Establishment, Cairo (Egypt). Jun 1994. 84p. (CONF-9406263–: National seminar on nuclear energy in everyday life, Cairo (Egypt), 23-29 Jun 1994). In *National seminar on nuclear energy in everyday life: lectures.* Order Number DE96601738. Source: OSTI; NTIS (US Sales Only); INIS.

It's a pity not everybody has got a radiation meter. Everybody who owns one, already knows that there is radiation everywhere. Turn on the meter where ever you go, and it starts counting radiation pulses. At some places it counts faster and at other slower. But there is no place where there is no radiation. If you put a radiation meter close to an old watch, an expensive camera, a smoke detector or certain crockery, or if you take it with you in a plane that takes off, the count rate increases. This means that the radiation is stronger close to these items and at higher altitudes. You can hear this with your ears and see it with you own eyes from the display. So, it must be true. The world we live in is radioactive. Radioactive substances and radiation existed on Earth before the first man was born. Radiation reaches us from the cosmos and is also emitted from radioactive substances in the ground, in construction material, in the food we eat and the air we breathe. All people are radioactive, too. For instance, all of us have got radioactive Radium and Polonium in our skeleton, radioactive Carbon and Potassium in our muscles and radioactive noble gases and Tritium in our lungs. The radiation emitted by your body can be measured by a very sensitive radiation meter called a Whole Body Counter.

30635 (PNL–6415-Rev.7) **Hanford Site National Environmental Policy Act (NEPA) characterization. Revision 7.** Cushing, C.E. (ed.) (and others); Baker, D.A.; Chamness, M.A. Pacific Northwest Lab., Richland, WA (United States). Sep 1995. 250p. Sponsored by USDOE, Washington, DC (United States). DOE Contract AC06-76RL01830. Order Number DE95017595. Source: OSTI; NTIS; GPO Dep.

This seventh revision of the Hanford Site National Environmental Policy (NEPA) Characterization presents current environmental data regarding the Hanford Site and its immediate environs. This information is intended for use in preparing Site-related NEPA documentation. Chapter 4.0 summarizes up-to-date information on climate and meteorology, geology, hydrology, environmental monitoring, ecology, history and archaeology, socioeconomics, land use, and noise levels prepared by Pacific Northwest Laboratory (PNL) staff. More detailed data are available from reference sources cited or from the authors. Chapter 5.0 was not updated from the sixth revision (1994). It describes models, including their principal underlying assumptions, that are to be used in simulating realized or potential impacts from nuclear materials at the Hanford Site. Included are models of radionuclide transport in groundwater and atmospheric pathways, and of radiation dose to populations via all known pathways from known initial conditions. The updated Chapter 6.0 provides the preparer with the federal and state regulations, DOE Orders and permits, and environmental standards directly applicable to the NEPA documents on the Hanford Site, following the structure of Chapter 4.0. No conclusions or recommendations are given in this report. Rather, it is a compilation of information on the Hanford Site environment that can be used directly by Site contractors. This information can also be used by any interested individual seeking baseline data on the Hanford Site and its past activities by which to evaluate projected activities and their impacts.

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Refer also to citation(s) 28648, 28649, 28650, 28651, 28652, 28653, 28654, 28796, 28797, 28927, 28963, 29086, 29112, 29348, 29349, 29443, 29444, 29447, 29809, 29844, 29906, 29913, 29915, 29932, 29933, 29946, 29977, 30167, 30356, 30557, 30584, 30591, 30625, 30711, 30742, 30756, 30772, 30775, 30836, 30875, 30904, 31108, 31209, 31333, 31365, 31402

30636 (ANL/ACL–95/2) **Development of mixed-waste analysis capability for graphite furnace atomic absorption spectrophotometry.** Bass, D.A.; TenKate, L.B.; Wroblewski, A. Argonne National Lab., IL (United States). Mar 1995. 20p. Sponsored by USDOE, Washington, DC (United States). DOE Contract W-31-109-ENG-38. Order Number DE95016336. Source: OSTI; NTIS; INIS; GPO Dep.

Graphite furnace atomic absorption spectrophotometer (GFAAS) are typically configured with ventilation to capture potentially toxic and corrosive gases emitted from the vaporization of sample aliquots. When radioactive elements are present, additional concerns (such as meeting safety guidelines and ALARA principles) must be addressed. This report describes a modification to a GFAAS that provides additional containment of vaporized sample aliquots. The modification was found to increase containment by a factor of 80, given expected operating conditions. The use of the

modification allows more mixed-waste samples to be analyzed, permits higher levels of radioactive samples to be analyzed, or exposes the analyst to less airborne radioactivity. The containment apparatus was attached to a Perkin-Elmer Zeeman 5000 spectrophotometer for analysis of mixed-waste samples; however, it could also be used on other systems and in other applications where greater containment of vaporized material is desired.

30637 (ANSTO/E–710) **Atmospheric tracer tests and assessment of a potential accident at the National Medical Cyclotron, Camperdown, NSW, Australia.** Clark, G.H.; Bartsch, F.J.K.; Stone, D.J.M. Australian Nuclear Science and Technology Organisation, Lucas Heights, NSW (Australia). Aug 1994. 27p. Order Number DE96602591. Source: OSTI; NTIS; INIS.

In order to assess the impact of a potential atmospheric release of radionuclides from the National Medical Cyclotron facility, in Camperdown, an atmospheric tracer release, sampling and analysis system using SF_6 was developed. During eight experiments conducted in a variety of meteorological conditions, ten samplers were located in the vicinity of the Cyclotron building and other nearby buildings on the rapid downward movement of the tracer gas plume. The atmospheric dilution factors which lead to the highest observed air concentrations were then applied to the releases of I^{123} and Xe^{123} from a potential accident scenario in order to assess the impact on nearby receptors. Even given the conservative assumptions about the release of I^{123}, the estimated radiation doses were at least an order of magnitude below the international standards for doses to member of the public. 27 refs., 8 tabs., 5 figs.

30638 (ARM–95-002) **Site scientific mission plan for the southern great plains CART site, July–December 1995.** Splitt, M.E. (Oklahoma Univ., Norman, OK (United States). Cooperative Inst. for Mesoscale Meteorological Studies); Lamb, P.J.; Sisterson, D.L. Argonne National Lab., IL (United States); Oklahoma Univ., Norman, OK (United States). Cooperative Inst. for Mesoscale Meteorological Studies. Jul 1995. 74p. Sponsored by USDOE, Washington, DC (United States). DOE Contract W-31109-ENG-38. Order Number DE96000148. Source: OSTI; NTIS; GPO Dep.

The Southern Great Plains (SGP) Cloud and Radiation Testbed (CART) site is designed to help satisfy the data needs Of the Atmospheric Radiation Measurement (ARM) Program Science Team. This document defines the scientific Priorities for site activities during the six months beginning on July 1, 1995, and looks forward in lesser detail to subsequent six-month periods. The Primary Purpose of this Site Scientific Mission Plan is to provide guidance for the development of plans for site operations. It also provides information on current plans to the ARM functional teams and serves to disseminate the plans more generally within the ARM Program and among the members of the Science Team. This document includes a description of the operational status of the site and the primary envisioned site activities, together with information concerning approved and proposed Intensive Observation Periods (IOPs). This plan is a living document that will be updated and reissued every six months as the observational facilities are developed, tested, and augmented and as Priorities are adjusted in response to developments in scientific planning and understanding.

30639 (BNL–61730) **The Brookhaven National Laboratory filter pack system for collection and determination of air pollutants.** Leahy, D.F.; Klotz, P.J.; Springston, S.R.; Daum, P.H. Brookhaven National Lab., Upton, NY (United States). Apr 1995. 35p. Sponsored by USDOE, Washington, DC (United States). DOE Contract AC02-76CH00016. Order Number DE96001132. Source: OSTI; NTIS; GPO Dep.

A filter pack system for sampling trace constituents in the atmosphere from aircraft and ground-based measurement platforms has been developed. The system simultaneously and quantitatively collects atmospheric aerosol, nitric acid, and sulfur dioxide using three sequential filter stages. The quartz aerosol filter is routinely analyzed for sulfate, nitrate, ammonium, and hydrogen ions, and specifically for sulfuric acid. The sodium chloride filter is analyzed for nitrate ion (from collected nitric acid), and the carbonate-glycerine filter for sulfate ion (from collected sulfur dioxide). Details of the procedures used for filter preparation, sampling, extraction and analysis are given.

30640 (BNL–62137) **An INMARSAT-C goes, and EIA485 hybrid communication system for global experiment control.** Reynolds, R.B.; Behrens, W. Brookhaven National Lab., Upton, NY (United States). [1995]. 8p. Sponsored by USDOE, Washington, DC (United States). DOE Contract AC02-76CH00016. (CONF-9510202–1: Oceans '95, San Diego, CA (United States), 9-12 Oct 1995). Order Number DE95016558. Source: OSTI; NTIS; GPO Dep.

The Atmosphere Radiation Measurement (ARM) program is constructing and radiation monitoring instrument that will be deployed at several island sites in the Tropical Western Pacific Ocean. The atmospheric radiation and cloud systems (ARCS) must operate the minimal maintenance for decades, producing and storing many megabytes of data per day. A reliable global communication system is an essential element of the ARCS design. It must provide immediate direct access to the equipment. High availability and reasonably low cost are essential for this very long-term deployment. Providing executive management and control, the communication system incorporates several special technologies to meet its requirements: (a) INMARSAT-C provides a simple two-way messaging capability. (b) Built-in GPS in the INMARSAT-C radio provides an accurate time standard. (c) The NOAA GOES satellite provides a one-way link for hourly health and basic measurement data. (d) An EIA485 local area network provides a digital link throughout the installation. (e) Node units located conveniently throughout the ARCS and linked by the EIA485 network allow an almost unlimited flexibility and expandability. (f) A robust packet protocol ensures message security and accuracy. The complete communication, control, and data acquisition system is described in detail. The ability of the system to adapt to other physical configurations (telephone, UHF, telnet) is discussed.

30641 (DOE/ER/61360–2) **Development of a SWIR solar spectral radiometer for the ARM Program. Final report.** Denver Univ., CO (United States). Dept. of Physics. Jul 1995. 8p. Sponsored by USDOE, Washington, DC (United States). DOE Contract FG02-92ER61360. Order Number DE96000409. Source: OSTI; NTIS; GPO Dep.

Solar radiation is the major source of energy input to the earth's atmospheric system. The majority of the energy in this radiation is contained in the region between 0.35μm and 1.0μm where the earth's atmosphere is relatively transparent. About one third of the energy occurs in the region from 1μm to 5μm. The atmosphere has a number of strong absorption bands in this spectral region and as a result, significant amounts of this radiation is deposited into the atmosphere. A knowledge of the absolute spectral intensity of the radiation reaching the earth's surface in this spectral region is important in understanding of radiation exchange in the earth-atmosphere system. Absolute solar spectral measurements in this spectral region are difficult, and it is only recently that the absolute spectral radiometric sources for this region have become available. The availability of such sources, coupled with development of reliable interferometers and associated small computers, appeared to make it possible to develop an absolute solar spectrometer system for field use. The object of this program was to investigate the feasibility of constructing such a system. There were three areas of particular concern about achieving the desired absolute accuracy. There were: (1) linearity; (2) sensitivity, and (3) stability. A system was assembled using a small commercial interferometer system, a solar tracking system and NIST traceable standard radiance source. This system was used to investigate these areas of concern. The results showed a system based on this design could be constructed that would be suitable for field operation by ARM site personnel.

30642 (DOE/NV/11432–197) **Environmental Monitoring Program summary data report – First Calendar Quarter 1995.** Black, S.C.; Glines, W.M.; Townsend, Y.E. (eds.). Reynolds Electrical and Engineering Co., Inc., Las Vegas, NV (United States). Jul 1995. 25p. Sponsored by USDOE, Washington, DC (United States). DOE Contract AC08-94NV11432. Order Number DE96000152. Source: OSTI; NTIS; INIS; GPO Dep.

During the first calendar quarter of 1995, air samples were collected and analyzed from 47 air particulate/halogen sampling

stations, 6 noble gas sampling stations, and 16 tritiated water vapor sampling stations. Surface water samples were collected and analyzed from 1 wastewater containment pond and 10 sewage lagoons. Groundwater samples were obtained from 11 potable and 1 non-potable supply wells and 6 drinking water consumption points. Ambient radiation levels were measured at 201 locations. Water sampling was conducted for analysis of bacteria, volatile organic compounds (VOCs), inorganic constituents, and water quality as required by the federal Safe Drinking Water Act and state of Nevada regulations. Samples were taken at various locations throughout all drinking water distribution systems on the NTS.

30643 (EML–563) **Long-term TLD measurements of environmental background radiation in the New York City Area.** Maiello, M. USDOE Environmental Measurements Lab., New York, NY (United States). Nov 1994. 30p. Sponsored by USDOE, Washington, DC (United States). Order Number DE95014918. Source: OSTI; NTIS; INIS; GPO Dep.

The results of month-long TLD measurements at seven locations within 150 km of New York City are reported for 12 years at a few locations and for up to 18 years at others. At some locations, multiple dosimeters were deployed to acquire concurrent indoor and outdoor measurements. The sites were varied and include an urban high-rise residence, three suburban backyards, a rural hillside, and the wooded outskirts of a nuclear power plant (nonoperational). Long-term mean dose rates in air ranged from 50.8 to 123.1 nGy h^{-1} (5.8 to 14.1 μR h^{-1}) across the area. The typical seasonal dose rate in air variations are presented for two of the sites and are briefly discussed in terms of soil conditions. The data indicate that it is possible to achieve monthly variations from the long-term mean as high as 20 to 40%. One of these locations was monitored for indoor (2 floors) and outdoor air dose rates. This allowed for a time series comparison to be performed illustrating the changing contribution of terrestrial radiation to the total dose rate relative to the steady building material-derived radioactivity. This site also permitted the calculation of indoor/outdoor ratios for two floors. Another suburban location yielded an indoor/outdoor ratio using ground floor dose-rate-in-air measurements. Also presented are mean annual dose rates in air showing a long-term decrease at some locations. A statistical Kendall test was performed to quantify the magnitude of the decrease. A definitive explanation of this trend requires further study.

30644 (EML–566) **Intercomparison of active and passive instruments for radon and radon progeny in North America.** George, A.C.; Tu, Keng-Wu; Knutson, E.O. USDOE Environmental Measurements Lab., New York, NY (United States). Feb 1995. 21p. Sponsored by USDOE, Washington, DC (United States). Order Number DE95014916. Source: OSTI; NTIS; INIS; GPO Dep.

An intercomparison exercise for radon and radon progeny instruments and methods was held at the Environmental Measurements Laboratory (EML) from April 22–May 2, 1994. The exercise was conducted in the new EML radon test and calibration facility in which conditions of exposure are very well controlled. The detection systems of the intercompared instruments consisted of. (1) pulse ionization chambers, (2) electret ionization chambers, (3) scintillation detectors, (4) alpha particle spectrometers with silicon diodes, surface barrier or diffused junction detectors, (5) registration of nuclear tracks in solid-state materials, and (6) activated carbon collectors counted by gamma-ray spectrometry or by alpha- and beta-liquid scintillation counting. 23 private firms, government laboratories and universities participated with a 165 passive integrating devices consisting of: Activated carbon collectors, nuclear alpha track detectors and electret ionization chambers, and 11 active and passive continuous radon monitors. Five portable integrating and continuous instruments were intercompared for radon progeny. Forty grab samples for radon progeny were taken by five groups that participated in person to test and evaluate their primary instruments and methods that measure individual radon progeny and the potential alpha energy concentration (PAEC) in indoor air. Results indicate that more than 80% of the measurements for radon performed with a variety of instruments, are within $\pm$10% of actual value. The majority of the instruments that measure individual radon progeny and the PAEC gave results that are in good agreement with the EML reference value. Radon progeny measurements made with continuous and integrating instruments are satisfactory with room for improvement.

30645 (ETDE/CH-mf–95787322, pp. 88-91) **Estimation of the natural non-methane VOC emissions from vegetation in Switzerland.** Andreani-Aksoyoglu, S. (Paul Scherrer Inst. (PSI), Villigen (Switzerland)); Keller, J. Paul Scherrer Inst. (PSI), Villigen (Switzerland). 1995. In *Paul Scherrer Institut annual report 1994. Annex V: PSI general energy technology newsletter 1994.* 123p. Source: OSTI; NTIS.

A biogenic volatile organic compounds (VOC) emission inventory for Switzerland was prepared for the first time to be used as input for 3-dimensional air pollution models. Emissions of VOCs from forests, agricultural crops and pasture were estimated to be about 24% of the total annual VOC emissions. Calculations showed that the forests are the main sources whereas emissions from crops are only 7% of the biogenic emissions, coming mainly from corn and pasture. The major contribution is released by the coniferous trees, especially from Norway spruce (picea bies) forests due to their abundance and high leaf biomass density. Although broad-leaved forests cover 27% of all the forests in Switzerland, their contribution to the biogenic emissions in only 2%. Monoterpene emission from the forests is predominantly higher than isoprene emission. Total annual biogenic VOC emission rate of 94 ktonnes/y is significantly higher than some estimates for Switzerland where the forests were classified simply as deciduous and coniferous. The difference is attributes to the high leaf biomass densities of Norway spruce and fir (abies alba) compared to the other conifers. (author) 1 fig., 2 tabs., 17 refs.

30646 (ETDE/CH-mf–95787322, pp. 92-95) **Asymmetric diurnal temperature trend in the alpine region.** Weber, R.O. (Paul Scherrer Inst. (PSI), Villigen (Switzerland)); Talkner, P.; Stefanicki, G. Paul Scherrer Inst. (PSI), Villigen (Switzerland). 1995. In *Paul Scherrer Institut annual report 1994. Annex V: PSI general energy technology newsletter 1994.* 123p. Source: OSTI; NTIS.

There exists quite general agreement that the global annual mean temperature raised about 0.5°C during the last hundred years. Recently, it has become obvious that this trend is quite inhomogeneous in various respects. Besides the spatial and seasonal variability of the observed trend a diurnal asymmetry of increase in temperature has been observed. In large regions over the continents the daily minimum temperature has increased noticeably faster than the daily maximum temperature. We are confirming this behaviour for low-altitude stations in central Europe. Moreover, we demonstrate that the maxima are representative for the mean temperature during daytime on the respective day and the minima for the mean temperature during nighttime. Data from isolated mountain stations have also been analyzed and show a consistent temporal behaviour. No diurnal asymmetry was observed for these stations. The good agreement of the times series led us to believe that the observed diurnal symmetry of the temperature change at mountain stations and the observed diurnal asymmetry at low-altitude stations are not caused by observational errors. We hope that these findings may provide a clue to a better understanding of the mechanisms of global warming. (author) 2 figs., 3 tabs., 6 refs.

30647 (ETDE/CH-mf–95787322, pp. 96-98) **Thermally forced local wind fields.** Kaufmann, P. (Paul Scherrer Inst. (PSI), Villigen (Switzerland)); Weber, R.O. Paul Scherrer Inst. (PSI), Villigen (Switzerland). 1995. In *Paul Scherrer Institut annual report 1994. Annex V: PSI general energy technology newsletter 1994.* 123p. Source: OSTI; NTIS.

The meteorological observations from the REKLIP/MISTRAL experiment have been further explored. Data from a year of one-hour mean wind observations from the dense network of 50 stations were grouped by means of a historical cluster analysis, and a catalogue of typical regional wind patterns in the Basel area was obtained. The resulting wind patterns have a distinct meteorological basis. We are now investigating whether some of the flow patterns are generated by local thermal forcing. A principal component analysis (PCA) of the temperature measurements at the stations reveals the main spatial patterns of thermal forcing. An analysis of the observed mean temperature behaviour in the individual clusters

shows good agreement with these forcing patterns. Thermally-driven valley wind systems appear to develop when the prevailing synoptic wind is not too strong. (author)4 figs., 1 tab., 6 refs.

30648 (ETDE-DE–199) **Kinetics and mechanisms of ozone formation by the atomspheric oxidation of selected hydrocarbons (LACTOZ). Final report.** Becker, K.H.; Barnes, I.; Zabel, F. Wuppertal Univ. (Gesamthochschule) (Germany). Lehrgebiet Physikalische Chemie. 30 Jun 1994. 175p. (In German, English). Sponsored by Bundesministerium fuer Forschung und Technologie, Bonn (Germany). Foerderkennzeichen BMFT 07EU708A. Order Number DE96706593. Source: OSTI; NTIS (US Sales Only).

Kinetic and mechanistic analysis shows that toluene and p-xylene produce after addition of OH by reaction with atmospheric oxygen, via ring cleavage without impact of NOx, dicarbonyls which rapidly photolyse and/or react with OH radicals. Simulation experiments carried out in photoreactors with toluene/alkane/NOx mixtures in air indicate that during the oxidation of toluene highly reactive ring cleavage products not involving NO_x are being formed which accelerate the ozone formation, however, secondary reactions of the products eventually leads to scavenging of NO_x and a retardation of the ozone formation. The kinetic data base of the thermal decomposition of peroxy nitrates has been completed, now important parameters can be reliably predicted. Product yields of OH reactions with isoprene were measured. Besides the main products methacrolein, methylvinylketone and formaldehyde, diols, hydroxycarbonyls and hydroperoxides have been observed. The results of the study of the ozone reaction with ethene cannot be explained by Criegee intermediates, k values have been corrected because of OH formation in the system. (orig.)

30649 (ETDE-DE–200) **Statistically optimal approaches to detecting anthropogenic climate change.** Report - Max-Planck-Institut fuer Meteorologie, v. 167. Hegerl, G.C. (Max-Planck-Institut fuer Meteorologie, Hamburg (Germany)); North, G.R. Max-Planck-Institut fuer Meteorologie, Hamburg (Germany). 8 Jun 1995. 27p. Order Number DE96706583. Source: OSTI; NTIS (US Sales Only).

Three statistically optimal approaches, which have been proposed recently for detecting anthropogenic climate change, are intercompared. It is shown that the core of all three methods is identical. However, the different approaches help to better understand the properties of the optimal detection. Also, the analysis allows us to examine the problems in implementing these optimal techniques in a common framework. An overview of practical considerations necessary for applying such an optimal method for detection is given. Recent applications show that such optimal methods present some basis for optimism toward a near-term program of progressively more significant detection of forced climate change. However, it is essential that good hypothesized signals and good information on climate variability be obtained, since erroneous variability, especially on the time scale of decades to centuries, can lead to erroneous conclusions. (orig.)

30650 (ETDE-DE–201) **Large scale circulation and meridional transports in the South Pacific.** Berichte aus dem Institut fuer Meereskunde an der Christian-Albrechts-Universitaet Kiel, v. 260. Holfort, J. Institut fuer Meereskunde an der Univ. Kiel (Germany); Kiel Univ. (Germany). Mathematisch-Naturwissenschaftliche Fakultaet. 1994. 127p. (In German). Order Number DE96706567. Source: OSTI; NTIS (US Sales Only).

Hydrographic section data sampled from 1983 to 1993 between 11 S and 30 S in the South Atlantic is used together with direct current measurements to infer the transport of heat, freshwater, salt and other tracers. After a short introduction and presentation of the hydrographic data set the direct current measurements at about 30 S are used in chapter 3 to calculate the mean mass transport of the Brazil Current and of bottom water through the Vema-Channel. The following chapter analyzes the different water masses of the region and the percentage of water masses are determined using an multi-parameter method. In chapter 5 the meridional transport and the associated errors of 4 zonal section are discussed. The velocity is calculated using geostrophy and several levels of no motion. Reasonable levels of no motion for the geostrophic calculation are infered using the water mass analysis of the previous chapter. The final heat transport estimate is done using an inverse calculation combining zonal and meridional sections with the mass transports from the direct current measurements. (orig./KW)

30651 (ETDE-DE–202) **A note on the vertical profile of water vapour variance.** Deutsche Forschungsanstalt fuer Luft- und Raumfahrt, Institut fuer Physik der Atmosphaere. Report, v. 25. Hauf, T. Deutsche Forschungsanstalt fuer Luft- und Raumfahrt e.V. (DLR), Wessling (Germany). Inst. fuer Physik der Atmosphaere. Feb 1995. 24p. Order Number DE96706561. Source: OSTI; NTIS (US Sales Only).

In a case study from a summer day in Central Europe, tropospheric profiles of (i) water vapour mixing ratio q(z), (ii) its standard deviation $\sigma_q(Z)$ along horizontal flight paths of ≈5 km length, and, (iii) the amplitude of power spectra were compared. Data from radio-sonde ascents and from high-resolution aircraft measurements was used. It is found that all three quantities decrease exponentially with height with only slightly differing scale heights in the range of 1500-2000 m. The variation coefficient σ_q/q decreases with height from 5% in the lower to 1-2.5% in the upper troposphere. The observed humidity variations can be related to height variations of air parcels over distances ranging from maximum 100 m in the lower to minimum 30 m in the upper troposphere. Related dynamic processes are discussed and it is hypothesized that gravity waves of the convection wave type may be the cause of the observed profile of humidity standard deviation. (orig.)

30652 (ETDE-DE–204) **Interactions between ocean circulation and the biological pumps in the global warming.** Report - Max-Planck-Institut fuer Meteorologie, v. 171. Maier-Reimer, E.; Mikolajewicz, U.; Winguth, A. Max-Planck-Institut fuer Meteorologie, Hamburg (Germany). Jul 1995. 39p. Order Number DE96706591. Source: OSTI; NTIS (US Sales Only).

We discuss the potential variations of the biological pump that can be expected from a change in the oceanic circulation in the ongoing global warming. The biogeochemical model is based on the assumption of a perfect stoichiometric compositon of organic material. Upwelling nutrients are transformed into organic particles that sink to the deep ocean according observed profiles. The physical circulation model is driven by the warming pattern as derived from scenario computations of a fully coupled ocean - atmosphere model. The amplitude of the warming is determined from the varying concentration of atmospheric CO_2. The model predicts a pronounced weakening of the thermohaline overturning. This is connected with a reduction of the transient uptake capacity of the ocean. It yields also a more effective removal or organic material from the surface which partly compensates the physical effects of solubility. Both effects are rather marginal for the evolution of atmospheric pCO_2. Running climate models and carbon cycle models separately seems to be justified. (orig.)

30653 (ETDE-DE–205) **Boundary layer turbulent transport and production/destruction of ozone during summertime smog episodes over the Swiss plateau.** Deutsche Forschungsanstalt fuer Luft- und Raumfahrt, Institut fuer Physik der Atmosphaere. Report, v. 27. Greenhut, G.K. (National Oceanic and Atmospheric Administration, Boulder, CO (United States). Environmental Research Labs.); Jochum, A.M.; Neininger, B. Deutsche Forschungsanstalt fuer Luft- und Raumfahrt e.V. (DLR), Wessling (Germany). Inst. fuer Physik der Atmosphaere. Feb 1995. 25p. Order Number DE96706563. Source: OSTI; NTIS (US Sales Only).

Turbulent fluxes of sensible and latent heat and ozone were measured aboard a German Aerospace Research Establishment motorglider over the Swiss Plateau during the first field experiment of the Swiss air pollution experiment POLLUMET. In the lower part of the boundary layer, the ozone fluxes are negative (downward) throughout the day as a result of deposition and photochemical destruction at the surface. In the upper part of the boundary layer, the ozone fluxes tend to be negative until mid-afternoon and then become positive. The change in sign occurs after the ozone concentration in the boundary layer exceeds that in the reservoir above the inversion. Downdrafts bringing air parcels with ozone deficits across the inversion then become major contributors to the flux. The positive fluxes at upper levels result in an increase in flux divergence in mid-afternoon that is balanced by a relatively large source term in the ozone concentration budget. (orig.)

30654 (ETDE-DE–206) **Definition of the polar vortex edge by LIDAR data of the stratospheric aerosol: a comparison with values of potential vorticity.** Deutsche Forschungsanstalt fuer Luft- und Raumfahrt, Institut fuer Physik der Atmosphaere. Report, v. 26. Dameris, M.; Wirth, M.; Renger, W.; Grewe, V.; Schumann, U. (ed.). Deutsche Forschungsanstalt fuer Luft- und Raumfahrt e.V. (DLR), Wessling (Germany). Inst. fuer Physik der Atmosphaere. Feb 1995. 24p. Order Number DE96706562. Source: OSTI; NTIS (US Sales Only).

In this paper LIDAR data of stratospheric aerosol measured during four long range flights (during Northern Hemisphere winter) by the German research aircraft TRAN-SALL are employed to describe the edge of the polar vortex. All flights directly crossed the polar vortex edge. The position of the boundary of the vortex is clearly identified in the data. Values of potential vorticity on isentropic surfaces often used to describe the structure and edge of the polar vortex are calculated as well. They are interpreted with respect to the aerosol data. A comparison with previously published diagnostics of the edges of the polar vortices shows good agreement. (orig.)

30655 (GKSS–94/E/64) **Modelling of cirrus optical properties.** Macke, A. GKSS-Forschungszentrum Geesthacht GmbH (Germnay); Hamburg Univ. (Germany). Fachbereich 15 - Geowissenschaften. 1994. 99p. (In German). Order Number DE96706569. Source: OSTI; NTIS (US Sales Only).

The present work describes single and multiple scattering of solar radiation at atmospheric ice crystals by means of a ray-tracing model, and a Monte-Carlo radiative transfer model. Besides the consideration of various particle shapes, the influence of crystal distortion and vibratory movement on the scattering properties of horizontally oriented crystals is analysed. By comparing the individual scattering properties, ice crystals are classified into ice columns and random fractals. The first seem to be representative for almost all column-like crystal-combinations, whereas the latter may represent the scattering properties of disordered crystals. The influence of different crystal size spectra, as well as vertical and spatial cloud inhomogeneities on the reflection behaviour of cirrus clouds is exemplary shown for ice columns, random fractals and ice spheres. Compared to ice columns, disordered crystals provide larger differences to the multiple scattering properties of ice spheres. Vertical structures of cirrus clouds provide an increase in albedo, while spatial cloud structures reduce the albedo. (orig.)

30656 (IC–95/99) **Influence of various room parameters upon radon daughter equilibrium indoors.** Islam, G.S. (International Centre for Theoretical Physics, Trieste (Italy)); Mazumdar, S.C.; Ashraf, M.A. International Centre for Theoretical Physics, Trieste (Italy). Jun 1995. 19p. Order Number DE96601763. Source: OSTI; NTIS (US Sales Only); INIS.

The parameters such as ventilation rate, attachment rate to aerosols and deposition processes, which influence the radon daughter equilibrium indoors, are discussed and the validity of the theoretical model checked by experiments. In agreement with the model calculations, the experimental data show, that the equilibrium factor F in rooms is mainly influenced by the rate of attachment to aerosols and the plateout of radon daughters. The equilibrium factor varies between 0.3 and 0.4 at an attachment rate of 300 h^{-1}. The influence of ventilation upon the free fraction of RaA(^{218}Pp)-atoms is also investigated. This is in good agreement with the results of the measurements carried out in different types of rooms at the University Campus of Rajshahi. (author). 20 refs, 3 figs, 3 tabs.

30657 (INEL–95/00444) **Evaluation of radiological releases from the Tomsk-7 accident.** Lussie, W.G. Lockheed Idaho Technologies Co., Idaho Falls, ID (United States). [1995]. 11p. Sponsored by USDOE, Washington, DC (United States). DOE Contract AC07-94ID13223. (CONF-9508178–1: Russia Federation/United States technical exchange on the non-reactor nuclear safety and waste management, Los Alamos, NM (United States), 14-17 Aug 1995). Order Number DE96001613. Source: OSTI; NTIS; INIS; GPO Dep.

On April 6, 1993, there was an uncontrolled release of radioactive material from the fuel reprocessing plant at the Siberian Chemical Combine in Tomsk. The release resulted from the rupture of an over-pressurized feed adjustment tank and subsequent explosion that destroyed the walls and roof of the operating gallery. Radioactive material was released through a 150 meter stack, as well as through the destroyed walls and roof. Relatively stable atmospheric conditions prevailed and a light snow was falling. The radiation release was not excessive, but the spread of radioactive material was compounded by the explosion. Radiation was detected about 26 km from the source. This paper summarizes the information available in the US regarding the release and, using reasonable assumptions, compares the calculated ground activity and radiation levels with the reported measured values.

30658 (KFK–5380) **Prediction of advected smog using weather forecast data of the Europa-Modell of the Deutscher Wetterdienst.** Sardemann, G.; Braeutigam, K.R.; Matzerath Boccaccini, C.; Fuerniss, B. Kernforschungszentrum Karlsruhe GmbH (Germany). Abt. fuer Angewandte Systemanalyse. Nov 1994. 157p. (In German). Sponsored by Umweltbundesamt, Berlin (Germany). Foerderkennzeichen UBA 30202003. Order Number DE96706558. Source: OSTI; NTIS (US Sales Only).

The dispersion model SMOROP replaces the former model SMOVO to be used for the forecast of SO_2-concentrations in the smog-early-warning-system of the Umweltbundesamt. The model had to be modified for the input of weather forecast data provided by the 'Europa-Modell' of the Deutscher Wetterdienst (DWD). In addition the emission data base has been brought up to date. SMOROP was thoroughly tested while running on a preliminary routine base on the computer facilities of the DWD in the winter months of the years 1992/93 and 1993/94. During this period daily SO_2-forecasts were provided for the smog-early-warning-system of the Umweltbundesamt without severe interruptions. The correspondence between forecasted SO_2-concentrations and the measurements at stations of the smog-early-warning-system is quite satifactory with adequate forecasts of the beginning, development and end of high concentration episodes. In the western part of Germany SO_2-concentration values can sometimes be overestimated. The quality of the forecasted regional distribution of SO_2-concentrations by SMOROP is slightly better than that by SMOVO but on the whole the differences between the two models are relatively small. (orig.)

30659 (KFK–5423) **RAT: A computational tool for retrieval of atmospheric trace gas profiles from infrared spectra.** Clarmann, T. v. Kernforschungszentrum Karlsruhe GmbH (Germany). Inst. fuer Meteorologie und Klimaforschung. Nov 1994. 105p. Order Number DE96706553. Source: OSTI; NTIS (US Sales Only).

A semi-operational computational tool for the quantitative spectroscopic analysis of the atmosphere's infrared radiation is presented. This algorithm has been developed for the retrieval of atmospheric parameters such as mixing ratios of trace gases, temperature or the aerosol content from measured spectra by the inverse solution of the radiative transfer equation. Furthermore, instrumental parameters like the spectral resolution or frequency shift can be adjusted automatically. Emission spectra as well as solar absorption spectra which are recorded by instruments looking from an air-borne or space-borne platform to the nadir or to the limb can be analyzed as well as spectra from instruments which look upward from a location anywhere inside the atmosphere. Different geometric applications can be combined with different mathematical optimization methods in a very flexible manner. This program proved its applicability during evaluation of data of numerous experiments. The basic strategies of the use of this algorithm in recent experiments is discussed. An implicit Monte-Carlo-like approach to error estimation, which also takes into account errors of a priori information, is proposed. (orig.)

30660 (KRC–90C-T05) **The Study on the Microscale Meteorological Changes Caused by Reservoir Construction for H/P Generation.** Park, S.E. (Seoul National Univ. (Korea, Republic of)); Kim, J.H.; Kwag, Y.S.; Shim, J.M.; Kim, B.K.; Kim, C.H.; In, H.J.; Yoo, T.C.; Lee, C.B.; Kim, M.K.; Kim, Y.K.; Cho, C.R.; Hong, N.G.; Choi, K.S.; Choi, J.C.; Mar, C.M.; Kim, S.; Lee, T.Y.; Park, Y.Y.;Korea Electric Power Corp. (KEPCO), Taejon (Korea, Republic of). Research Center. 1993. 589p. (In Korean). Order Number DE96703575. Source: OSTI; NTIS (US Sales Only).

Hydroelectric power generation requires the construction of a dam that can hold a large body of water inland. The increased water surface, which in turn, modifies the natural energy balance on the surface. Consequently, the newly achieved energy balance on the surface results in possible modifications of the physical and biological environments in the manner that we are not normally expected. Hence, the objectives of this study were (1) to document the characteristics of local weather phenomena in the region of newly constructed Doam dam which is located in the eastern central part of korea in a mountainous valley of the Taeback mountains, and (2) to estimate the long-range effects of meteorological changes on the life style of local people and the industrial activities operated in that range. To conduct this study, seven meteorological stations were designated around the Doam dam lake and meteorological variables such as air temperature, humidity, precipitation, and solar radiation were monitored for two years. Upper air observation at the dam region were made once a season for 24 hours. They included airsonde observations every three hour interval for a day and pibal observations at every hour. Characteristic features of synoptic weather conditions and micrometeorological phenomena in the vicinity of the dam were defined by using field data and using appropriate models developed for this purpose. Microclimate change were predicted in this study, but no major change in weather was assumed. In order to document certain adverse effects to local ecosystem, detailed ecosystem analysis was also studied in the watershed area.

30661 (LA-UR–95-2794) **A reduced grid model for shallow flows on the sphere.** Reisner, J.M. (Los Alamos National Lab., NM (United States)); Margolin, L.G.; Smolarkiewicz, P.K. Los Alamos National Lab., NM (United States). [1995]. 10p. Sponsored by USDOE, Washington, DC (United States). DOE Contract W-7405-ENG-36. (CONF-9507179–1: Parallel CFD, Pasadena, CA (United States), Jul 1995). Order Number DE95017852. Source: OSTI; NTIS; GPO Dep.

The authors describe a numerical model for simulating shallow water flows on a rotating sphere. The model is augmented by a reduced grid capability that increases the allowable time step based on stability requirements, and leads to significant improvements in computational efficiency. The model is based on finite difference techniques, and in particular on the nonoscillatory forward-in-time advection scheme MPDATA. They have implemented the model on the massively parallel CM-5, and have used it to simulate shallow water flows representative of global atmospheric motions. Here they present simulations of two flows, the Rossby-Haurwitz wave of period four, a nearly steady pattern with a complex balance of large and small scale motions, and also a zonal flow perturbed by an obstacle. They compare the accuracy and efficiency of using the reduced grid option with that of the original model. The authors also present simulations at several levels of resolution to show how the efficiency of the model scales with problem size.

30662 (LBL–37200, pp. 233-238) **Reservoir storage and containment of greenhouse gases.** Weir, G.J. (Industrial Research Ltd., Lower Hutt (New Zealand)); White, S.P.; Kissling, W.M. Lawrence Berkeley Lab., CA (United States). Mar 1995. DOE Contract AC03-76SF00098. (CONF-9503110–: TOUGH 95: transport of unsaturated ground water and heat workshop, Berkeley, CA (United States), 20-22 Mar 1995). In *Proceedings of the TOUGH Workshop '95 Lawrence Berkeley Laboratory, Berkeley, California, March 20–22, 1995.* 380p. Order Number DE95014788. Source: OSTI; NTIS; GPO Dep.

This paper considers the injection of CO_2 into underground reservoirs. Computer models are used to investigate the disposal of CO_2 generated by an 800 MW power station. A number of scenarios are considered, some of which result in containment of the CO_2 over very long time scales and others result in the escape of the CO_2 after a few hundred years.

30663 (LBL–37200, pp. 331-334) **Air-tough: A fully 3-dimensional linking of atmosphere with soil using eddy diffusivity concept and V-TOUGH.** Montazer, P. (Multimedia Environmental Technology, Inc., Newport Beach, CA (United States)). Lawrence Berkeley Lab., CA (United States). Mar 1995. DOE Contract AC03-76SF00098. (CONF-9503110–: TOUGH 95: transport of unsaturated ground water and heat workshop, Berkeley, CA (United States), 20-22 Mar 1995). In *Proceedings of the TOUGH Workshop '95 Lawrence Berkeley Laboratory, Berkeley, California, March 20–22, 1995.* 380p. Order Number DE95014788. Source: OSTI; NTIS; GPO Dep.

In arid climates, evapotranspiration is a strongly-coupled thermodynamic process that is controlled by the interaction of the atmospheric boundary layer and the upper soil surface. Simulation of this process requires a fully-coupled thermodynamic multi-phase fluid-flow and energy-transport code. Such a code was developed in a previous investigation using V-TOUGH. The resulting efficient computer code, A-TOUGH, simulates the effect of dynamic atmospheric fluctuations on vapor movement between the soil and the atmosphere and the resulting moisture movement in the soil. However, the coupling between the atmosphere and soil employed eddy diffusivity which was only a function of time and not a function of space. In the present study the code is extended to allow spatial as well as temporal variation of eddy diffusivity.

30664 (MISU-IMI-CM–85) **Evaluation of a global 3-D model of tropospheric oxidized nitrogen.** Gallardo, L.; Rodhe, H. Stockholm Univ. (Sweden). Dept. of Meteorology; International Meteorological Inst., Stockholm (Sweden). Jun 1995. 39p. Order Number DE96703706. Source: OSTI; NTIS.

A 3-D climatological tracer transport model (MOGUNTIA) has been used to simulate the global tropospheric distribution of oxidized nitrogen. This model considers a scheme of the background photochemistry and NO_3-N_2O_5 -reactions on aerosol, as well as formation of organic nitrates. The simulations are evaluated with respect to nitrate wet deposition. The model simulates wet deposition fluxes within a factor of two at 66% of the observation sites. The evaluation of gas phase concentrations of oxidized nitrogen indicates too fast an oxidation of NO_x downwind from high emission areas. Sensitivity tests with respect to total amounts of NO_x emitted, and the vertical distribution of the lightning source have been performed. Our analysis indicates that the global lightning source strength is unlikely to be higher than 20 TgN/a. However, discrepancies between modeled and measured nitrate wet deposition, in addition to the underestimate of total nitrate over remote marine areas, suggest that the oceanic lightning emissions of NO_x might be underestimated in the model. 81 refs, 6 figs, 7 tabs

30665 (NEI-NO–579) **Two- and three-dimensional model calculations of the photochemistry of the troposphere.** Berntsen, T.K. Oslo Univ. (Norway). 1994. 154p. Order Number DE96703728. Source: OSTI; NTIS.

This doctoral thesis consists of four included papers. Paper 1 develops a two-dimensional chemical-dynamical model of the atmosphere with emphasis on the methane oxidation. Paper 2 presents a three-dimensional chemical/transport model simulation for Europe and the eastern Atlantic region. Paper 3 extends the model to the global troposphere. Paper 4 applies the model to a study of the impact of possible future increases in anthropogenic sources of ozone precursors in Asia. 226 refs., 54 figs., 29 tabs.

30666 (NREL/CP–200-8098, pp. 1408-1417) **Approaching the climate challenge: The experience of PacifiCorp.** Edmonds, B. (PacifiCorp, Portland, OR (United States)). National Renewable Energy Lab., Golden, CO (United States). [1995]. (CONF-9508104–: 2. meeting on biomass of the Americas, Portland, OR (United States), 21-24 Aug 1995). In *Second biomass conference of the Americas: Energy, environment, agriculture, and industry. Proceedings.* 1741p. Order Number DE95009230. Source: OSTI.

Despite many uncertainties regarding the impacts of increasing atmospheric concentrations of carbon dioxide and other greenhouse gases on the global climate, policies and actions intended to reduce the perceived threat of climate change are being actively discussed and developed at the international, national, state, and local levels. PacifiCorp, an electric utility serving 1.3 million customers headquartered in Portland, Oregon, has been a pioneer in exploring ways to offset emissions using domestic tree planting. In 1992, PacifiCorp began implementing pilot carbon offset projects to test different offset techniques while working through implementation issues. Forestry was chosen for PacifiCorp's initial offset efforts because forestry can provide credible carbon benefits at low cost and forestry programs could be funded within the limits of PacifiCorp's pilot efforts. Forestry initiatives also are, for PacifiCorp,

a distinct endeavor that cannot be confused with the company's normal business activities and they have ancillary environmental benefits beyond carbon sequestration such as watershed restoration and enhancement of biodiversity. PacifiCorp has pursued four projects to date: reforestation in southern Oregon working with the Oregon Department of Forestry, reforestation through Oregon's Forest Resource Trust, reforestration in eastern Washington, and urban forestry in Salt Lake City. The projects were chosen for their program benefits and ability to satisfy specific rigorous carbon offset criteria. PacifiCorp is evaluating additional future project opportunities; possibilities include utilization of methane from sewage treatment facilities, capture of methane from underground coal mines, and carbon offsets from ethanol production. PacifiCorp's pilot projects have demonstrated the advantages of a flexible carbon offset approach. The offsets produced are credible, reliable, and verifiable, and provide ancillary benefits to the utility's customers.

30667 (NREL/CP–433-7748, pp. 239-242) **Chemistry and kinetics of chlorine oxides under stratospheric conditions.** Greene, F.T. (Midwest Research Institute, Kansas City, MO (United States)); Robaugh, D.A. National Renewable Energy Lab., Golden, CO (United States). Mar 1995. Contract NASW-4371. (CONF-9410343–: Applications of free-jet, molecular beam, mass spectrometric sampling conference, Estes Park, CO (United States), 11-14 Oct 1994). In *Applications of free-jet, molecular beam, mass spectrometric sampling: Proceedings.* 305p. Order Number DE95004052. Source: OSTI; NTIS; GPO Dep.

The accepted mechanism for the destruction of O_3 by chlorinated species in the stratosphere at equatorial latitudes does not apply under Antarctic winter conditions because of the low intensity of solar uv radiation. Consequently, a number of novel chemical mechanisms were proposed for ozone destruction, including one which invoked ClO dimer. This study was therefore undertaken to determine whether ClO dimer, which had not been positively identified, was a significant species under Antarctic stratospheric conditions and to determine its rate of formation.

30668 (PNL–10575) **Hanford Site environmental data for calendar year 1994: Surface and Columbia River.** Bisping, L.E. Pacific Northwest Lab., Richland, WA (United States). Jul 1995. 300p. Sponsored by USDOE, Washington, DC (United States). DOE Contract AC06-76RL01830. Order Number DE96001151. Source: OSTI; NTIS; INIS; GPO Dep.

Environmental monitoring at the Hanford Site, located in southeastern Washington State, is conducted by Battelle Memorial Institute, Pacific Northwest Division, as part of its contract to operate the Pacific Northwest Laboratory (PNL) for the US Department of Energy. The data collected provide a historical record of radionuclide and radiation levels attributable to natural causes, worldwide fallout, and Hanford operations. Data are also collected to monitor several chemicals. Pacific Northwest Laboratory publishes an annual environmental report for the Hanford Site each calendar year. The Hanford Site Environmental Report for Calendar Year 1994 describes the Site mission and activities, general environmental features, radiological and chemical releases from operations, status of compliance with environmental regulations, status of programs to accomplish compliance, and environmental monitoring activities and results. The report includes a summary of offsite and onsite environmental monitoring data collected during 1994 b PNL's Environmental Monitoring Program. Appendix A of that report contains data summaries created from raw surface and river monitoring data. This volume contains the actual raw data used to create the summaries.

30669 (PNL–10789) **User's guide for PLTWIND Version 1.0: PC-based software for generating plots of monitored wind data and gridded wind fields for Hanford emergency response applications.** Glantz, C.S.; Burk, K.W. Pacific Northwest Lab., Richland, WA (United States). Sep 1995. 40p. Sponsored by USDOE, Washington, DC (United States). DOE Contract AC06-76RL01830. Order Number DE96000744. Source: OSTI; NTIS; GPO Dep.

This document is a user's guide for the PLoT Near-Surface WIND (PLTWIND) modeling system. PLTWIND is a personal-computer-based software product designed to produce graphical displays of Hanford wind observations and model-generated wind fields. The real-time wind data processed by PLTWIND are acquired from the mainframe computer system at the Hanford Meteorology Station and copied to PLTWIND systems by the Hanford Local Area Network (HLAN). PLTWIND is designed fbr operation on an IBM-compatible PC with a connection to the HLAN. An HP-compatible pen plotter or laser printer (with a minimum of 1.5 megabytes of memory and a Plotter-in-a-Cartridge hardware) is required to generate hardcopies of PLTWTND's graphical products. PLTWM's products are intended for use by emergency response personnel in evaluating atmospheric dispersion characteristics in the near-surface environment. Model products provide important atmospheric information to hazard evaluators; however, these products are only tools for assessing near-surface atmospheric transport and should not be interrupted as providing definitive representation of atmospheric conditions.

30670 (SAND–95-2062C) **Multi Spectral Pushbroom Imaging Radiometer (MPIR) for remote sensing cloud studies.** Phipps, G.S.; Grotbeck, C.L. Sandia National Labs., Albuquerque, NM (United States). [1995]. 4p. Sponsored by USDOE, Washington, DC (United States). DOE Contract AC04-94AL85000. (CONF-9510217–1: Cloud impacts on DOD operations and systems, Boston, MA (United States), 24-26 Oct 1995). Order Number DE96000684. Source: OSTI; NTIS; GPO Dep.

A Multi Spectral Pushbroom Imaging Radiometer (MPIR) has been developed as are relatively inexpensive (~$IM/copy), well-calibrated,imaging radiometer for aircraft studies of cloud properties. The instrument is designed to fly on an Unmanned Aerospace Vehicle (UAV) platform at altitudes from the surface up to 20 km. MPIR is being developed to support the Unmanned Aerospace Vehicle portion of the Department of Energy's Atmospheric Radiation Measurements program (ARM/UAV). Radiation-cloud interactions are the dominant uncertainty in the current General Circulation Models used for atmospheric climate studies. Reduction of this uncertainty is a top scientific priority of the US Global Change Research Program and the ARM program. While the DOE's ARM program measures a num-ber of parameters from the ground-based Clouds and Radiation Testbed sites, it was recognized from the outset that other key parameters are best measured by sustained airborne data taking. These measurements are critical in our understanding of global change issues as well as for improved atmospheric and near space weather forecasting applications.

30671 (UCRL-ID–114972-2, pp. 21, Paper 1) **The effect of increased levels of carbon dioxide on chlorophyll fluorescence and photosynthetic pigments in pinus ponderosa.** Anschel, D. (State Univ. of New York, Buffalo, NY (United States)). Lawrence Livermore National Lab., CA (United States). 6 May 1994. (CONF-9405328–Absts.: Science and Engineering Research Semester (SERS) student symposium, Livermore, CA (United States), 6 May 1994). In *SERS intership: Spring 1994 abstracts and research papers.* 195p. Order Number DE95014118. Source: OSTI; NTIS; GPO Dep.

Levels of atmospheric carbon dioxide have been increasing at an unprecedented rate in modern times. In response to this situation, we have initiated a long-term study of a forest species' response to elevated carbon dioxide levels. We have set up a facility for subjecting P. ponderosa to ambient, ambien' + 175 μ1 1^{-1}, and ambient + 350 μ1 1^{-1} CO_2. This report specifically concentrates on the effects of elevated CO_2 on the photosynthetic system, as indicated by chlorophyll fluorescence and pigment assays. We tested for intraspecific variability by selecting nine different families of trees from five different geographic areas of California. There are differential responses to carbon dioxide treatments which appear to be dependent upon the tree's genotype, as indicated by the relative efficiencies of photochemical electron flow in photosystem II (Fv/Fm). During the same testing period Fv/Fm varied by as much as 21.1% relative to ambient in the treated groups. Total chlorophyll, chlorophyll α and carotenoid values all showed statistically significant ($p<0.05$) drops in the treatment groups regardless of genotype. Chlorophyll α at one time showed the most dramatic drop of 3 mg/m2 in the + 350 μ1 1^{-1} CO_2 group versus the ambient. Findings for both photosynthetic pigments and chlorophyll fluorescence vary somewhat over the course of several months.

30672 (UCRL-ID–121413) **Intercomparison of the spectral characteristics of 200 hPa kinetic energy in some AMIP simulations. PCMDI report No. 23.** Boyle, J.S. Lawrence Livermore National Lab., CA (United States). Jul 1995. 30p. Sponsored by USDOE, Washington, DC (United States). DOE Contract W-7405-ENG-48. Order Number DE96001010. Source: OSTI; NTIS; GPO Dep.

The 200 hPa kinetic energy budget terms are represented by means of their spherical harmonic components for a number of AMIP simulations. The data used are the monthly mean wind fields for 1979 to 1988 decadal simulations. The budget terms are decomposed into the divergent and rotational components. The comparison is limited to the lower wavenumbers so as to be within the nominal limits imposed by the models with the coarsest spatial resolution. The results show considerable differences among the models. The comparison is best for the rotational wind and decades for the divergent components, especially the conversion term. There is some ambiguity among the models as to the sign of some terms at certain wavenumbers. The models tend to overestimate the Walker type (east-west) divergent circulations compared to the Hadley type (north-south) compared to recent NMC and ECMWF operational analyses. The inter-model differences are substantial when viewed in light of the differences in the observational analyses and ensemble differences for the ECMWF model. However, the median values of all the models taken together are usually in fair agreement with observational values.

30673 (UCRL-ID–121414) **The effect of horizontal resolution on cloud radiative forcing in the ECMWF model. PCMDI report No. 22.** Potter, G.L. Lawrence Livermore National Lab., CA (United States). May 1995. 14p. Sponsored by USDOE, Washington, DC (United States). DOE Contract W-7405-ENG-48. Order Number DE96001011. Source: OSTI; NTIS; GPO Dep.

With expanding computer capability and capacity there has been considerable interest in increasing the resolution in GCMs. The primary driving force behind this are two fold: (1) increased resolution may reduce the systematic errors inherent in parameterization of sub-grid scale processes, and (2) higher resolution may improve confidence in regional scale studies of climatic features that are orographically influenced – such as the effect of the Tibetan Plateau on the East Asian Monsoon. This study focuses on the effect of horizontal resolution on the spatial and temporal systematic errors of cloud radiative forcing and its components. In this paper, the top-of-the-atmosphere radiation fields are taken from a series of simulations using the European Centre for Medium Range Forecasts (ECMWF) general circulation model (cycle 33), run at four different horizontal resolutions. Section 2 discusses the concept of cloud radiative forcing and describes the simulations from the ECMWF model. The observed global field of cloud forcing from ERBE is presented in section 3 along with the model-produced fields of the net solar and longwave cloud forcing. The seasonal effect of forcing is described in section 4, and the results are summarized in section 5.

30674 (UCRL-ID–121415) **Estimates of zonally averaged tropical diabatic heating in AMIP GCM simulations. PCMDI report No. 25.** Boyle, J.S. Lawrence Livermore National Lab., CA (United States). Jul 1995. 42p. Sponsored by USDOE, Washington, DC (United States). DOE Contract W-7405-ENG-48. Order Number DE96001012. Source: OSTI; NTIS; GPO Dep.

An understanding of the processess that generate the atmospheric diabatic heating rates is basic to an understanding of the time averaged general circulation of the atmosphere and also circulation anomalies. Knowledge of the sources and sinks of atmospheric heating enables a fuller understanding of the nature of the atmospheric circulation. An actual assesment of the diabatic heating rates in the atmosphere is a difficult problem that has been approached in a number of ways. One way is to estimate the total diabatic heating by estimating individual components associated with the radiative fluxes, the latent heat release, and sensible heat fluxes. An example of this approach is provided by Newell. Another approach is to estimate the net heating rates from consideration of the balance required of the mass and wind variables as routinely observed and analyzed. This budget computation has been done using the thermodynamic equation and more recently done by using the vorticity and thermodynamic equations. Schaak and Johnson compute the heating rates through the integration of the isentropic mass continuity equation. The estimates of heating arrived at all these methods are severely handicapped by the uncertainties in the observational data and analyses. In addition the estimates of the individual heating components suffer an additional source of error from the parameterizations used to approximate these quantities.

30675 (UCRL-ID–121512) **Radiative forcing calculations for CH_3Br.** Grossman, A.S. (Lawrence Livermore National Lab., CA (United States)); Blass, W.E.; Wuebbles, D.J. Lawrence Livermore National Lab., CA (United States). Jun 1995. 8p. Sponsored by USDOE, Washington, DC (United States);Environmental Protection Agency, Washington, DC (United States). DOE Contract W-7405-ENG-48. Order Number DE95017070. Source: OSTI; NTIS; INIS; GPO Dep.

Methyl Bromide, CH_3Br, is the major organobromine species in the lower atmosphere and is a primary source of bromine in the stratosphere. It has a lifetime of 1.3 years. The IR methyl bromide spectra in the atmospheric window region, 7–13μ, was determined using a well tested Coriolis resonance and ℓ-doubling (and ℓ-resonance) computational system. A radiative forcing value of 0.00493 W/m^2/ppbv was obtained for CH_3Br and is approximately linear in the background abundance. This value is about 2 percent of the forcing of CFC-11 and about 278 times the forcing of $C0_2$, on a per molecule basis. The radiative forcing calculation is used to estimate the global warming potential (GWP) of CH_3Br. The results give GWPs for CH_3Br of the order of 13 for an integration period of 20 years and 4 for an integration period of 100 years (assuming $C0_2$ = 1, following IPCC [1994]). While CH_3Br has a GWP which is approximately 25 percent of the GWP of CH_4, the current emission rates are too low to cause serious atmospheric greenhouse heating effects at this time.

30676 (UCRL-ID–121923) **Documentation of the AMIP models on the World Wide Web.** Phillips, T.J. Lawrence Livermore National Lab., CA (United States). Aug 1995. 20p. Sponsored by USDOE, Washington, DC (United States). DOE Contract W-7405-ENG-48. Order Number DE96001021. Source: OSTI; NTIS; GPO Dep.

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The intercomparison of atmospheric general circulation model (AGCM) experiments of a similar type has become an increasingly popular methodology for assessing the strengths and weaknesses of climate simulations. In such endeavors, attempts to attribute differences among the simulations to specific model properties require, as a minimum prerequisite, the accurate and comprehensive documentation of these features. Regrettably however, atmospheric model documentation typically is fragmentary and scattered across numerous publications. It is also often inaccurate, in the sense that the pace of model development and the proliferation of new model versions usually outstrip their recorded descriptions. More often than not, the detailed configuration of a model for a particular experiment also is undocumented. In addition, there may be much unevenness in the descriptions of different facets of models. This incompleteness usually is replicated in published results of an intercomparison experiment, in that participating models' features often are summarized only perfunctorily. Summary documentation of the numerics, dynamics, and physics of models participating in the Atmospheric Model Intercomparison Project (AMIP) is now available on the Internet's World Wide Web. This paper describes the principal attributes of the electronic model documentation and provides instructions on how to access it.

30677 (UCRL-JC–116595) **Growth response of Pinus ponderosa seedlings and mature tree branches to acid rain and ozone exposure.** Anderson, P.D. (USDA Forest Service, Forestry Sciences Lab., Rhinelander, WI (United States)); Houpis, J.L.J.; Helms, J.A. Lawrence Livermore National Lab., CA (United States). Oct 1994. 8p. Sponsored by USDOE, Washington, DC (United States);California State Government, Sacramento, CA (United States). DOE Contract W-7405-ENG-48. (CONF-9409301–2: 16. international meeting for specialists in air pollution effects on forest ecosystems, air pollution and multiple stresses, New Brunswick

(Canada), 7-9 Sep 1994). Order Number DE96000359. Source: OSTI; NTIS; INIS; GPO Dep.

Forests of the central and southern Sierra Nevada in California have been subjected to chronic damage by ozone and other atmospheric pollutants for the past several decades. Until recently, pollutant exposure of northern Sierra Nevada forests has been mild but increasing population and changes in land use throughout the Sacramento Valley and Sierra Nevada foothills may lead to increased pollutant damage in these forests. Although, better documented in other regions of the United States, little is known regarding the potential for acidic precipitation damage to Sierra Nevada forests. Only recently have studies directed towards understanding the potential interactive effects of ozone and acidic precipitation been undertaken. A key issue in resolving potential regional impacts of pollutants on forests is the extent to which research results can be scaled across genotypes and life-stages. Most of the pollution research to date has been performed using seedlings with varying degrees of genetic control. It is important to determine if the results obtained in such studies can be extrapolated to mature trees and to different genetic sources. In this paper, we present results from a one-year study examining the interactive effects of foliar exposure to acidic rain and ozone on the growth of ponderosa pine (Pinus ponderosa), a conifer known to be sensitive to ozone. The response to pollutants is characterized for both seedlings and mature tree branches of three genotypes grown in a common environment.

30678 (UCRL-JC–121047) **Evaluation of ARAC's participation in a long-range transport experiment.** Pace, J.C.; Pobanz, B.M.; Foster, C.S.; Baskett, R.L.; Vogt, P.J.; Schalk, W.W. III. Lawrence Livermore National Lab., CA (United States). Aug 1995. 7p. Sponsored by USDOE, Washington, DC (United States). DOE Contract W-7405-ENG-48. (CONF-9501108–2: 9. joint conference on the applications of air pollution meteorology, Atlanta, GA (United States), 28 Jan - 2 feb 1995). Order Number DE96000366. Source: OSTI; INIS; NTIS; GPO Dep.

The 1994 European Tracer Experiment (ETEX) involved two releases of inert tracer gas in western France, allowing subsequent detection at many locations across Europe. Twenty four operational and research facilities from 20 countries made predictions of the motion of the released plume and the resulting concentrations detected at the sampler locations. This paper describes participation by the Lawrence Livermore National Laboratory's Atmospheric Release Advisory Capability (ARAC) in ETEX. In its role as a real-time emergency response center, ARAC operates a suite of numerical models which simulate the advection and diffusion of airborne releases, and which calculate the estimated downwind concentration of the released material. The models and procedures used by ARAC to participate in ETEX were essentially the same as those which would be used to respond to a release at any previously unspecified location.

30679 (UCRL-JC–121086) **Neutral surface layer turbulence over complex terrain.** Bowen, B.M. Lawrence Livermore National Lab., CA (United States). Sep 1995. 10p. Sponsored by USDOE, Washington, DC (United States). DOE Contract W-7405-ENG-48. (CONF-9501108–1: 9. joint conference on the applications of air pollution meteorology, Atlanta, GA (United States), 28 Jan - 2 feb 1995). Order Number DE96000365. Source: OSTI; NTIS; GPO Dep.

Accurate turbulence estimates are important input to atmospheric dispersion models since they characterize downwind dispersion and hence, potential pollutant concentrations. When only basic wind information is available, an atmospheric modeler must first estimate roughness length (z_0,) at the location of interest, (μ^*) from similarity theory using average wind speed (μ) and z_0, and finally apply experimentally derived relationships to determine the turbulence intensities. Even when turbulence coefficients are measured, the turbulence profile must be estimated in the surface layer, using, for example, the power law recommended in a US Environmental Protection Agency guidance document. In this study, turbulent intensities and wind profiles are analyzed in eight direction sectors during near neutral stability. "Local" and "regional" roughness lengths are calculated from wind speed profiles and from longitudinal turbulence intensities (σ_μ) at both sites. With "regional" roughness length, complex terrain features are in effect the roughness elements. Profiles of median, 15-minute averaged turbulence intensities σ_μ, σ_ν and σ_w are calculated at both sites. Profiles of median σ_θ and σ_ϕ are also calculated using four mean values of regional z_0 at both sites. Finally, differences between widely-used turbulence relationships and the relationships determined in this study, and their possible effect on model results, are discussed.

30680 (UCRL-JC–121202) **Nonlinear principal component analysis of climate data.** Boyle, J.; Sengupta, S. Lawrence Livermore National Lab., CA (United States). Jun 1995. 8p. Sponsored by USDOE, Washington, DC (United States). DOE Contract W-7405-ENG-48. (CONF-9506191–4: 6. international meeting on statistical climatology, Galway (Ireland), Jun 1995). Order Number DE95017075. Source: OSTI; NTIS; GPO Dep.

This paper presents the details of the nonlinear principal component analysis of climate data. Topic discussed include: connection with principal component analysis; network architecture; analysis of the standard routine (PRINC); and results.

30681 (UCRL-JC–121506) **Numerical simulations of turbulent dispersion around buildings via a lagrangian stochastic particle model.** Lee, R.L. (Lawrence Livermore National Lab., CA (United States)); Naeslund, E. Lawrence Livermore National Lab., CA (United States). Jul 1995. 8p. Sponsored by USDOE, Washington, DC (United States). DOE Contract W-7405-ENG-48. (CONF-9511131–1: 7. international symposium on measurement and modeling of environmental flows, San Francisco, CA (United States), 12-17 Nov 1995). Order Number DE96000100. Source: OSTI; NTIS; GPO Dep.

This paper describes a numerical modeling approach that can be used to provide estimates of air concentrations due to emissions at industrial sites or other sites where buildings may have an important impact on the dispersion patterns. The procedure consists of two sequential steps: (i) Prediction of mean flow and turbulence fields via a turbulent flow model; and, (ii) Employment of the calculated flow and Turbulence fields to drive a Lagrangian Stochastic Particle Model. Two flow scenarios in which the approaching mean wind is assumed to be at 90° and 30° to the building complex are used as input to the Lagrangian model. The first calculation is based on an earlier transport and diffusion simulation that employed an existing particle-in-cell flux-gradient dispersion model. The second simulation is used to demonstrate the strong spatial variations that the concentration field exhibit within the highly complex separation zones of building wakes. The relationship between concentration levels and toxic load are discussed for the case of a chemical spill.

30682 (UCRL-JC–121765) **ARAC: A support capability for emergency managers.** Pace, J.C. (and others); Sullivan, T.J.; Baskett, R.L. Lawrence Livermore National Lab., CA (United States). Aug 1995. 13p. Sponsored by USDOE, Washington, DC (United States). DOE Contract W-7405-ENG-48. (CONF-9508161–1: NEMA energency management information technology conference, Berryville, VA (United States), 22-24 Aug 1995). Order Number DE95017817. Source: OSTI; NTIS; GPO Dep.

This paper is intended to introduce to the non-radiological emergency management community the 20-year operational history of the Atmospheric Release Advisory Capability (ARAC), its concept of operations, and its applicability for use in support of emergency management decision makers. ARAC is a centralized federal facility for assessing atmospheric releases of hazardous materials in real time, using a robust suite of three-dimensional atmospheric transport and diffusion models, extensive geophysical and source-description databases, automated meteorological data acquisition systems, and experienced staff members. Although originally conceived to respond to nuclear accidents, the ARAC system has proven to be extremely adaptable, and has been used successfully during a wide variety of nonradiological hazardous chemical situations. ARAC represents a proven, validated, operational support capability for atmospheric hazardous releases.

30683 (WHC-SA–2885) **Assessment for potential radionuclide emissions from stacks and diffuse and fugitive sources on the Hanford Site.** Davis, W.E. (Westinghouse Hanford Co., Richland, WA (United States)); Schmidt, J.W.; Gleckler, B.P.;

Rhoads, K. Westinghouse Hanford Co., Richland, WA (United States). Jun 1995. 32p. Sponsored by USDOE, Washington, DC (United States). DOE Contract AC06-87RL10930. (CONF-9507119–1: Summer national meeting of the American Institute of Chemical Engineers, Boston, MA (United States), 30 Jul - 2 aug 1995). Order Number DE95016338. Source: OSTI; NTIS; INIS; GPO Dep.

By using the six EPA-approved methods, instead of only the original back calculation method for assessing the 84 WHC registered stacks, the number of stacks requiring continuous monitoring was reduced from 32 to 19 stacks. The intercomparison between results showed that no correlation existed between back calculations and release fractions. Also the NDA, upstream air samples, and powder release fraction method results were at least three orders of magnitude lower then the back calculations results. The most surprising results of the assessment came from NDA. NDA was found to be an easy method for assessing potential emissions. For the nine stacks assessed by NDA, all nine of the stacks would have required continuous monitoring when assessed by back calculations. However, when NDA was applied all stacks had potential emissions that would cause an EDE below the > 0.1 mrem/y standard. Apparent DFs for the HEPA filter systems were calculated for eight nondesignated stacks with emissions above the detection limit. These apparent DFs ranged from 0.5 to 250. The EDE dose to the MEI was calculated to be 0.028 mrem/y for diffuse and fugitive emissions from the Hanford Sited. This is well below the > 0.1 mrem/y standard.

30684 (WSRC-RP–93-1322) **AXAIR and PUFF-PLUME Comparison.** Simpkins, A.A.; Kurzeja, R.J. Westinghouse Savannah River Co., Aiken, SC (United States). 28 Sep 1995. 12p. Sponsored by USDOE, Washington, DC (United States). DOE Contract AC09-89SR18035. Order Number DE96060003. Source: OSTI; NTIS; GPO Dep.

A test version of AXAIR has been prepared to compare with PUFF-PLUME. The test version of AXAIR applies the same meteorological conditions as PUFF-PLUME and also the dispersion coefficients have been changed to be the same as those in PUFF-PLUME. The test version of AXAIR and PUFF-PLUME produce virtually the same doses with the differences being less than 3% for the select cases with similar input. Differences and similarities in the models are also addressed.

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Refer also to citation(s) 28717, 28763, 28805, 28824, 28891, 28893, 28900, 28905, 28908, 28912, 28914, 28915, 28924, 28937, 28958, 28963, 28965, 28966, 28969, 28984, 28990, 28992, 29006, 29007, 29008, 29015, 29016, 29017, 29018, 29019, 29023, 29030, 29031, 29032, 29036, 29043, 29045, 29046, 29055, 29057, 29059, 29061, 29065, 29066, 29070, 29071, 29072, 29074, 29078, 29079, 29081, 29084, 29086, 29089, 29098, 29102, 29108, 29125, 29231, 29351, 29446, 29452, 29932, 29933, 29935, 29939, 29940, 29953, 29965, 30228, 30304, 30584, 30625, 30642, 30662, 30668, 30818, 30836, 30847, 30848, 30851, 31209, 31323, 31324, 31355, 31402

30685 (ANL/ES/CP–85526) **Sequential extraction evaluation of heavy-metal-contaminated soil: How clean is clean?** Li, Wen; Peters, R.W.; Brewster, M.D.; Miller, G.A. Argonne National Lab., IL (United States). [1995]. 14p. Sponsored by Department of Defense, Washington, DC (United States). DOE Contract W-31-109-ENG-38. (CONF-950646–25: Air and Waste Management Association meeting, San Antonio, TX (United States), 18-23 Jun 1995). Order Number DE95013716. Source: OSTI; NTIS; GPO Dep.

As a result of industrial and military operations, large amounts of land have become contaminated with heavy metals. A growing public awareness of metal toxicity in soils and water has forced increased treatment and improved remediation techniques. To develop an adequate knowledge base to definitively judge the usefulness of the remediation technology requires some basic research in how the contaminants are bound in the soil. In this study, the classic five-step sequential extractions were performed on heavy-metal-contaminated soil from Aberdeen Proving Ground to determine the speciation of the metal forms. This technique speciates the heavy metal distribution into an easily extractable (exchangeable) form, carbonates, reducible oxides, organically-bound forms, and residual forms. In order to compare the results of these fractionations with the amount of heavy metals extracted by chelating agents, multi-stage extractions with EDTA were also performed. The results were used to determine the feasibility of using soil washing and soil flushing techniques for remediating the Aberdeen metals-contaminated soils.

30686 (ANL/ESD/TM–96) **A compendium of fracture flow models, 1994.** Diodato, D.M. Argonne National Lab., IL (United States). Nov 1994. 88p. Sponsored by Department of Defense, Washington, DC (United States). DOE Contract W-31109-ENG-38. Order Number DE96001006. Source: OSTI; NTIS; GPO Dep.

The report is designed to be used as a decision-making aid for individuals who need to simulate fluid flow in fractured porous media. Fracture flow codes of varying capability in the public and private domain were identified in a survey of government, academia, and industry. The selection and use of an appropriate code requires conceptualization of the geology, physics, and chemistry (for transport) of the fracture flow problem to be solved. Conceptual models that have been invoked to describe fluid flow in fractured porous media include explicit discrete fracture, dual continuum (porosity and/or permeability), discrete fracture network, multiple interacting continua, multipermeability/multiporosity, and single equivalent continuum. The explicit discrete-fracture model is a "near-field" representation, the single equivalent continuum model is a "far-field" representation, and the dual-continuum model is intermediate to those end members. Of these, the dual-continuum model is the most widely employed. The concept of multiple interacting continua has been applied in a limited number of examples. Multipermeability/multiporosity provides a unified conceptual model. The ability to accurately describe fracture flow phenomena will continue to improve as a result of advances in fracture flow research and computing technology. This improvement will result in enhanced capability to protect the public environment, safety, and health.

30687 (BNL–62130) **Future land use plan.** Brookhaven National Lab., Upton, NY (United States). 31 Aug 1995. 100p. Sponsored by USDOE, Washington, DC (United States). DOE Contract AC02-76CH00016. Order Number DE95017837. Source: OSTI; NTIS; INIS; GPO Dep.

The US Department of Energy's (DOE) changing mission, coupled with the need to apply appropriate cleanup standards for current and future environmental restoration, prompted the need for a process to determine preferred Future Land Uses for DOE-owned sites. DOE began the "Future Land Use" initiative in 1994 to ensure that its cleanup efforts reflect the surrounding communities' interests in future land use. This plan presents the results of a study of stakeholder-preferred future land uses for the Brookhaven National Laboratory (BNL), located in central Long Island, New York. The plan gives the Laboratory's view of its future development over the next 20 years, as well as land uses preferred by the community were BNL ever to cease operations as a national laboratory (the post-BNL scenario). The plan provides an overview of the physical features of the site including its history, topography, geology/hydrogeology, biological inventory, floodplains, wetlands, climate, and atmosphere. Utility systems and current environmental operations are described including waste management, waste water treatment, hazardous waste management, refuse disposal and ground water management. To complement the physical descriptions of the site, demographics are discussed, including overviews of the surrounding areas, laboratory population, and economic and non-economic impacts.

30688 (CONF-940553–85) **Ground-water recharge in Fortymile Wash near Yucca Mountain, Nevada, 1992–1993.** Savard, C.S. Geological Survey, Mercury, NV (United States). [1994]. 9p. Sponsored by USDOE, Washington, DC (United States). DOE Contract AI08-92NV10874. From International high-level radioactive waste management conference; Las Vegas, NV (United States); 22-26 May 1994. Order Number DE96001451. Source: OSTI; NTIS; INIS; GPO Dep.

Quantification of the ground-water recharge from streamflow in the Fortymile Wash watershed will contribute to regional ground-water studies. Regional ground-water studies are an important component in the studies evaluating the ground-water flow system as a barrier to the potential migration of radionuclides from the potential underground high-level nuclear waste repository. Knowledge gained in understanding the ground-water recharge mechanisms and pathways in the Pah Canyon area, which is 10 km to the northeast of Yucca Mountain, may transfer to Yucca site specific studies. The current data collection network in Fortymile Canyon does not permit quantification of ground-water recharge, however a qualitative understanding of ground-water recharge was developed from these data.

30689 (CONF-940553–87) **Characterization of a desert soil sequence at Yucca Mountain, NV.** Guertal, W.R. (Foothill Engineering, Inc., Mercury, NV (United States)); Hofmann, L.L. Hudson, D.B.; Flint, A.L. Geological Survey, Denver, CO (United States). [1994]. 7p. Sponsored by USDOE, Washington, DC (United States). DOE Contract AI08-92NV10874. From International high-level radioactive waste management conference; Las Vegas, NV (United States); 22-26 May 1994. Order Number DE96001453. Source: OSTI; NTIS; INIS; GPO Dep.

Yucca Mountain, Nevada, is currently being evaluated as a potential site for a geologic repository for high level radioactive waste. Hydrologic evaluation of the unsaturated zone of Yucca Mountain is being conducted as an integrated set of surface and subsurface-based activities with a common objective to characterize the temporal and spatial distribution of water flux through the potential repository. Yucca Mountain is covered with a thin to thick layer of colluvial/alluvial materials, where there are not bedrock outcrops. It is across this surface boundary that all infiltration and all exfiltration occurs. This surface boundary effects water movement through the unsaturated zone. Characterization of the hydrologic properties of surficial materials is then a necessary step for short term characterization goals and for long term modeling.

30690 (CONF-940553–88) **Verification of a 1-dimensional model for predicting shallow infiltration at Yucca Mountain.** Hevesi, J.A. (Geological Survey, Mercury, NV (United States)); Flint, A.L.; Flint, L.E. Geological Survey, Denver, CO (United States). [1994]. 10p. Sponsored by USDOE, Washington, DC (United States). DOE Contract AI08-92NV10874. From International high-level radioactive waste management conference; Las Vegas, NV (United States); 22-26 May 1994. Order Number DE96001454. Source: OSTI; NTIS; INIS; GPO Dep.

A characterization of net infiltration rates is needed for site-scale evaluation of groundwater flow at Yucca Mountain, Nevada. Shallow infiltration caused by precipitation may be a potential source of net infiltration. A 1-dimensional finite difference model of shallow infiltration with a moisture-dependant evapotranspiration function and a hypothetical root-zone was calibrated and verified using measured water content profiles, measured precipitation, and estimated potential evapotranspiration. Monthly water content profiles obtained from January 1990 through October 1993 were measured by geophysical logging of 3 boreholes located in the alluvium channel of Pagany Wash on Yucca Mountain. The profiles indicated seasonal wetting and drying of the alluvium in response to winter season precipitation and summer season evapotranspiration above a depth of 2.5 meters. A gradual drying trend below a depth of 2.5 meters was interpreted as long-term redistribution and/or evapotranspiration following a deep infiltration event caused by runoff in Pagany Wash during 1984. An initial model, calibrated using the 1990 to 1 992 record, did not provide a satisfactory prediction of water content profiles measured in 1993 following a relatively wet winter season. A re-calibrated model using a modified, seasonally-dependent evapotranspiration function provided an improved fit to the total record. The new model provided a satisfactory verification using water content changes measured at a distance of 6 meters from the calibration site, but was less satisfactory in predicting changes at a distance of 18 meters.

30691 (CONF-940553–91) **Shallow infiltration processes in arid watersheds at Yucca Mountain, Nevada.** Flint, L.E. (Geological Survey, Mercury, NV (United States)); Flint, A.L. Hevesi, J.A. Geological Survey, Denver, CO (United States). [1994]. 6p. Sponsored by USDOE, Washington, DC (United States). DOE Contract AI08-92NV10874. From International high-level radioactive waste management conference; Las Vegas, NV (United States); 22-26 May 1994. Order Number DE96001457. Source: OSTI; NTIS; INIS; GPO Dep.

A conceptual model of shallow infiltration processes at Yucca Mountain, Nevada, was developed for use in hydrologic flow models to characterize net infiltration (the penetration of the wetting front below the zone influenced by evapotranspiration). The model categorizes the surface of the site into four infiltration zones. These zones were identified as ridgetops, sideslopes, terraces, and active channels on the basis of water-content changes with depth and time. The maximum depth of measured water-content change at a specific site is a function of surface storage capacity, the timing and magnitude of precipitation, evapotranspiration, and the degree of saturation of surficial materials overlying fractured bedrock. Measured water-content profiles for the four zones indicated that the potential for net infiltration is higher when evapotranspiration is low (i.e winter, cloudy periods), where surface concentration of water is likely to occur (i.e. depressions, channels), where surface storage capacity is low, and where fractured bedrock is close to the surface.

30692 (CONF-940553–95) **Fluid inclusion studies of calcite veins from Yucca Mountain, Nevada, Tuffs: Environment of formation.** Roedder, E. (Harvard Univ., Cambridge, MA (United States)); Whelan, J.F.; Vaniman, D.T. Geological Survey, Denver, CO (United States). [1994]. 4p. Sponsored by USDOE, Washington, DC (United States). DOE Contract AI08-92NV10874. From International high-level radioactive waste management conference; Las Vegas, NV (United States); 22-26 May 1994. Order Number DE96001461. Source: OSTI; NTIS; INIS; GPO Dep.

Calcite vein and vug fillings at four depths (130-314m), all above the present water table in USW G-1 bore hole at Yucca Mountain, Nevada, contain primary fluid inclusions with variable vapor/liquid raitos: Most of these inclusions are either full of liquid or full of vapor. The liquid-filled inclusions show that most of the host calcite crystallized from fluids at <100°C. The vapor-filled inclusions provide evidence that a separate vapor phase was present in the fluid during crystallization. Studies of these vapor-filled inclusions on the microscope crushing stage were interpreted in an earlier paper as indicating trapping of an air-water-CO_2 vapor phase at "<100°C". Our new studies reveal the additional presence of major methane in the vapor-filled inclusion, indicating even lower temperatures of trapping, perhaps at near-surface temperatures. They also show that the host calcite crystals grew from a flowing film of water on the walls of fractures open to the atmosphere, the vapor-filled inclusions representing bubbles that exsolved from this film onto the crystal surface.

30693 (CONF-940553–96) **Isotopic studies of Yucca Mountain soil fluids and carbonate pedogenesis.** McConnaughey, T.A.; Whelan, J.F.; Wickland, K.P.; Moscati, R.J. Geological Survey, Denver, CO (United States). [1994]. 5p. Sponsored by USDOE, Washington, DC (United States). DOE Contract AI08-92NV10874. From International high-level radioactive waste management conference; Las Vegas, NV (United States); 22-26 May 1994. Order Number DE96001462. Source: OSTI; NTIS; INIS; GPO Dep.

Secondary carbonates occurring within the soils, faults, and subsurface fractures of Yucca Mountain contain some of the best available records of paleoclimate and palehydrology for the potential radioactive waste repository site. This article discusses conceptual and analytical advances being made with regard to the interpretation of stable isotope data from pedogenic carbonates, specifically related to the ^{13}C content of soil CO_2, $CaCO_3$, precipitation mechanisms, and isotopic fractionations between parent fluids and precipitating carbonates. The ^{13}C content of soil carbon dioxide from Yucca Mountain and vicinity shows most of the usual patterns expected in such contexts: Decreasing ^{13}C content with depth decreasing ^{13}C with altitude and reduced ^{13}C during spring. These patterns exist within the domain of a noisy data set; soil and vegetational heterogeneities, weather, and other factors apparently

contribute to isotopic variability in the system. Several soil calcification mechanisms appear to be important, involving characteristic physical and chemical environments and isotopic fractionations. When CO_2 loss from thin soil solutions is an important driving factor, carbonates may contain excess heavy isotopes, compared to equilibrium precipitation with soil fluids. When root calcification serves as a proton generator for plant absorption of soil nutrients, heavy isotope deficiencies are likely. Successive cycles of dissolution and reprecipitation mix and redistribute pedogenic carbonates, and tend to isotopically homogenize and equilibrate pedogenic carbonates with soil fluids.

30694 (CONF-9408107–7) **Differentiation of Aroclors in environmental samples using linear discrimination.** Ma, C.Y.; Bayne, C.K. Oak Ridge National Lab., TN (United States). [1995]. 18p. Sponsored by USDOE, Washington, DC (United States). DOE Contract AC05-84OR21400. From American Statistical Association; Toronto (Canada); 14-18 Aug 1994. Order Number DE96000248. Source: OSTI; NTIS; GPO Dep.

Environmental samples suspected of containing polychlorinated biphenyls (PCBs) and analyzed by Environmental Protection Agency (EPA) methods frequently contain non-PCB components, such as phthalates, polynuclear aromatic hydrocarbons, or organochlorine pesticides. The presence of these interferences can often obscure the gas chromatographic (GC) patterns and cause problems in differentiating the Aroclor types by visual inspection. Because EPA methods require the identification of Aroclor types in order to determine which Aroclor standard should be used for the quantitation calibration, and possibly, to trace the source of PCB occurrences, electron capture negative ion chemical ionization (ECNICI) mass spectrometry was used to provide additional parameters for discriminating PCB congeners from the interferences. In this study, eight Aroclors (i.e., 1016, 1232, 1242, 1248, 1254, 1260, 1262, and 1268) were analyzed by ECNICI for a range of concentration levels. Using selective ion display, the ion abundances of the prominent peaks in the isotopic clusters of molecular ions were measured for eight PCB homologs (Cl_2-Cl_9) within their GC retention time windows for each sample. Corresponding relative ion abundances from eight Aroclor standards were used as classification training sets. These training sets were used to develop a classification algorithm using standard linear discriminant analysis to classify the PCBs present in an unknown sample(s) as a specific Aroclor. This technique employed a sequential application of two sets of linear discriminant functions to successfully identify known EPA quality control and environmental samples. However, classifications of Aroclor mixtures were less successful.

30695 (CONF-950596–1) **Personal exposure to environmental tobacco smoke in workplace and away from work settings: A 16 city case study.** Jenkins, R.A.; Palausky, M.A.; Counts, R.W.; Guerin, M.R.; Dindal, A.B.; Bayne, C.K. Oak Ridge National Lab., TN (United States). [1995]. 10p. Sponsored by USDOE, Washington, DC (United States). DOE Contract AC05-84OR21400. Center for Indoor Air Research, Linthicum. MD Contract No. E; RD From Conference on measurement of toxic and related air pollutants; Durham, NC (United States); 2-5 May 1995. Order Number DE95016355. Source: OSTI; NTIS; GPO Dep.

A large study of personal exposure of non-smokers to environmental tobacco smoke (ETS) has been conducted in 16 cities in the United States. Individual participants wear two personal sampling pumps, one each at work and away-from-work. Samples of breathing zone air are collected, and subsequently analyzed for both particle phase and gas phase markers of ETS, including respirable suspended particulate matter (RSP), UV-absorbing and fluorescing particulate matter, solanesol, nicotine, 3-ethenyl pyridine, and myosmine. In addition, prior- and post-exposure saliva samples are collected, in order that smoking status may be determined using salivary cotinine. Participants are segregated into a 2×2 factorial study design: smoking and non-smoking homes and workplaces. A comparison of the demographic distribution of the sample population with that of the United States indicates that the sample population is more female and of higher socioeconomic status. The data indicates that median 8-hour or 16-hour exposure levels are considerably lower than those which would be extrapolated from short duration area measurements. Median exposure levels of nicotine, 3-ethenyl pyridine, and RSP were 0.034, 0.029, and 23 $\mu g/m^3$ respectively in non-smoking workplaces, vs. 0.21, 0.16, and 23 $\mu g/m^3$ in workplaces where smoking was observed. Median 16-hour exposure levels for these same components away from work where subjects observed tobacco products in use were 0.36, 0.25, and 23 $\mu g/m^3$, compared with 0.024, 0.019, and 15 $\mu g/m^3$ when no tobacco products were observed.

30696 (DOE/AL/62350–132-Rev.2) **UMTRA Project water sampling and analysis plan, Gunnison, Colorado. Revision 2.** Jacobs Engineering Group, Inc., Albuquerque, NM (United States). Sep 1995. 40p. Sponsored by USDOE, Washington, DC (United States). DOE Contract AC04-91AL62350. Order Number DE96000653. Source: OSTI; NTIS; INIS; GPO Dep.

Surface remedial action at the Gunnison Uranium Mill Tailings Remedial Action Project site began in 1992; completion is expected in 1995. Ground water and surface water will be sampled semiannually at the Gunnison processing site (GUN-01) and disposal site (GUN-08). Results of previous water sampling at the Gunnison processing site indicate that ground water in the alluvium is contaminated by the former uranium processing activities. Background ground water conditions have been established in the uppermost aquifer (Tertiary gravels) at the Gunnison disposal site. Semiannual water sampling is scheduled for the spring and fall. Water quality sampling is conducted at the processing site (1) to ensure protection of human health and the environment, (2) for ground water compliance monitoring during remedial action construction, and (3) to define the extent of contamination. At the processing site, the frequency and duration of sampling will be dependent upon the nature and extent of residual contamination and the compliance strategy chosen. The monitor well locations provide a representative distribution of sampling points to characterize ground water quality and ground water flow conditions in the vicinity of the sites. The list of analytes has been modified with time to reflect constituents that are related to uranium processing activities and the parameters needed for geochemical evaluation.

30697 (DOE/CE/15544–T12) **Develop a field grid system for yield mapping and machine control. Quarterly report, July 1, 1995–September 30, 1995.** Hart, F.; Windish, J. South Dakota State Univ., Brookings, SD (United States). [1995]. 40p. Sponsored by USDOE, Washington, DC (United States). DOE Contract FG01-92CE15544. Order Number DE96000249. Source: OSTI; NTIS; GPO Dep.

Build and test the Field Grid Sense system for yield mapping and machine control during harvesting. Secondly, use Field Grid Sense with chemical application equipment to demonstrate a workable in-field system. More specifically, the operation of the patented hardware/software Field Grid Sense (FGS) system will be tested in crop harvesting to demonstrate the system's utility and to analyze the flexibility of operation under true field conditions. Additionally, FGS will again be used with chemical application equipment - equipment that needs modification to correct one or two slight shortcomings. This action will create improved systems and establish the worthiness, efficiency and necessity of chemical application equipment that is controlled and directed via the FGS package.

30698 (DOE/EM–0251) **Landfill stabilization focus area: Technology summary.** USDOE Assistant Secretary for Environmental Management, Washington, DC (United States). Office of the Deputy Assistant Secretary for Technology Development. Jun 1995. 166p. Sponsored by USDOE, Washington, DC (United States). Order Number DE95016176. Source: OSTI; NTIS; INIS; GPO Dep.

Landfills within the DOE Complex as of 1990 are estimated to contain 3 million cubic meters of buried waste. The DOE facilities where the waste is predominantly located are at Hanford, the Savannah River Site (SRS), the Idaho National Engineering Laboratory (INEL), the Los Alamos National Laboratory (LANL), the Oak Ridge Reservation (ORR), the Nevada Test Site (NTS), and the Rocky Flats Plant (RFP). Landfills include buried waste, whether on pads or in trenches, sumps, ponds, pits, cribs, heaps and piles, auger holes, caissons, and sanitary landfills. Approximately half of all DOE buried waste was disposed of before 1970. Disposal regulations at that time permitted the commingling of various types of waste (i.e., transuranic, low-level radioactive, hazardous). As a result, much of the buried waste throughout the DOE Complex is

presently believed to be contaminated with both hazardous and radioactive materials. DOE buried waste typically includes transuranic-contaminated radioactive waste (TRU), low-level radioactive waste (LLW), hazardous waste per 40 CFR 26 1, greater-than-class-C waste per CFR 61 55 (GTCC), mixed TRU waste, and mixed LLW. The mission of the Landfill Stabilization Focus Area is to develop, demonstrate, and deliver safer,more cost-effective and efficient technologies which satisfy DOE site needs for the remediation and management of landfills. The LSFA is structured into five technology areas to meet the landfill remediation and management needs across the DOE complex. These technology areas are: assessment, retrieval, treatment, containment, and stabilization. Technical tasks in each of these areas are reviewed.

30699 (DOE/ID–22117) **Radionuclides, stable isotopes, inorganic constituents, and organic compounds in water from selected wells and springs from the southern boundary of the Idaho National Engineering Laboratory to the Hagerman Area, Idaho, 1993.** Bartholomay, R.C.; Edwards, D.D.; Campbell, L.J. Geological Survey, Idaho Falls, ID (United States). Water Resources Div. Oct 1994. 35p. Sponsored by Geological Survey, Reston, VA (United States). (USGS-OFR–94-503). Order Number DE96001159. Source: OSTI; NTIS; INIS; GPO Dep.

The US Geological Survey and the Idaho Department of Water Resources, in response to a request from the US Department of Energy, sampled 19 sites as part of a long-term project to monitor water quality of the Snake River Plain aquifer from the southern boundary of the Idaho National Engineering Laboratory to the Hagerman area. Water samples were collected and analyzed for selected radionuclides, stable isotopes, inorganic constituents, and organic compounds. The samples were collected from seven irrigation wells, four domestic wells, two springs, one stock well, three dairy wells, one observation well, and one commercial well. Two quality assurance samples also were collected and analyzed. None of the radionuclide, inorganic constituent, or organic compound concentrations exceeded the established maximum contaminant levels for drinking water. Most of the radionuclide and inorganic constituent concentrations exceeded their respective reporting levels. All samples analyzed for surfactants and dissolved organic carbon had concentrations that equaled or exceeded their reporting levels. The ethylbenzene concentration in one water sample exceeded the reporting level.

30700 (DOE/ID–22120) **Analysis of steady-state flow and advective transport in the Eastern Snake River Plain Aquifer System, Idaho.** Ackerman, D.J. USDOE Idaho Operations Office, Idaho Falls, ID (United States). 1995. 25p. Sponsored by Geological Survey, Reston, VA (United States). (USGS-WRI–94-4257). Order Number DE96001160. Source: OSTI; NTIS; GPO Dep.

The regional aquifer system of the eastern Snake River Plain is an important component of the hydrologic system in eastern Idaho. The aquifer was thought to be the largest unified ground-water reservoir on the North American continent but is probably second to the Floridian aquifer in the southeastern United States. Flow in the aquifer is from major recharge areas in the northeastern part of the plain to discharge areas in the southwestern part. A comprehensive analysis of the occurrence and movement of water in the aquifer was presented by Garabedian. The analysis included a description of the recharge and discharge, the hydraulic properties, and a numerical model of the aquifer. The purposes of this report are to: (1) describe compartments in the aquifer that function as intermediate and regional flow systems, (2) describe pathlines for flow originating at or near the water table, and (3) quantify traveltimes for adjective transport originating at or near the water table. The model constructed for this study and described in this report will aid those concerned with the management and protection of the aquifer. The model will serve as a tool to further our understanding of the aquifer and will aid in assessing the needs for future flow and transport studies of the aquifer.

30701 (DOE/NV–11432-195) **Status of the flora and fauna on the Nevada Test Site, 1994: Results of continuing Basic Environmental Monitoring January through December 1994.** Hunter, R.B. (comp.). Reynolds Electrical and Engineering Co., Inc., Las Vegas, NV (United States). Sep 1995. 363p. Sponsored by USDOE, Washington, DC (United States). DOE Contract AC08-94NV11432. Order Number DE96000768. Source: OSTI; NTIS; INIS; GPO Dep.

This is the final progress report of a Department of Energy (DOE), Nevada operations Office (NV), program to monitor the ecology of the Nevada Test Site (NTS). The eight-year Basic Environmental Compliance and Monitoring Program (BECAMP) included meeting goals of understanding the spatial and temporal changes of plants and animals on the NTS, and determining the effects of DOE operations on those plants and animals. Determination of the changes was addressed through monitoring the most common plant and animal species at undisturbed (baseline) plots located in the major NTS valleys and mesas. One plot in Yucca Flat, the site of most nuclear weapons tests, was monitored annually, while other baseline plots were censused on a three- or four-year cycle. Effects of DOE operations were examined at sites of major disturbances, related to both DOE operations and natural disturbance mechanisms, censused on a three-year cycle. This report concentrates on work completed in 1994.

30702 (DOE/NV/11508–01) **Exposure assessment of groundwater transport of tritium from the Shoal Site.** Chapman, J.; Pohlmann, K.; Andricevic, R. Nevada Univ., Las Vegas, NV (United States). Water Resources Center. Apr 1995. 28p. Sponsored by USDOE, Washington, DC (United States). DOE Contract AC08-95NV11508. Order Number DE95017517. Source: OSTI; NTIS; GPO Dep.

The US Department of Energy (DOE) and its predecessor agencies are responsible for nuclear weapons research and development as part of the national defense program. These activities include underground nuclear testing, and a small number of such tests have been conducted at sites distant from the Nevada Test Site (NTS). An NTS site-wide Environmental Impact Statement (EIS) is being prepared in 1995 and includes the two offsite test areas in Nevada: the Shoal site and the Central Nevada Test Area. At the time of these tests, evaluations of project safety and predictions of groundwater transport of contaminants were made, and the tests were deemed safe to the public. These early evaluations were not considered sufficient for the EIS, so DOE decided to perform a new exposure assessment for the Shoal site. The basic scenario evaluated for this exposure assessment is transport of tritium from the Shoal underground nuclear test by groundwater to a receptor well where an individual drinks the contaminated water for 70 years, centered around the time of peak tritium concentration. This scenario is entirely hypothetical because, as of 1995, there are no known occurrences of humans drinking water downgradient from the test. Four specific scenarios are analyzed because of uncertainty in flowpath direction. Two of these presume that wells are drilled at the boundary of the current DOE land withdrawal and are then used for drinking water supply. Wells do not currently exist at these locations and thus the resultant risks do not apply to any current populations; however, there are no controls to prevent such wells from being drilled in the future. The two other scenarios consider transport to the first existing wells along possible flowpaths. These wells are currently used only seasonally to water cattle, and as such, these risks also do not apply to current populations.

30703 (EGG–10617-1238) **Viewfoils for environmental capabilities presentation.** EG and G Energy Measurements, Inc., Las Vegas, NV (United States). 1 Apr 1992. 35p. Sponsored by USDOE, Washington, DC (United States). DOE Contract AC08-88NV10617. Order Number DE96001110. Source: OSTI; NTIS; INIS; GPO Dep.

This document contains information about the environmental applications of aerial surveys. It discusses the accuracy, dependability, history, advantages, and sensitivity of aerial surveys. Also included, are a brief overview of in-situ gamma spectroscopy and samples of aerial surveys. This document contains entirely of an outline and viewfoils for the presentation.

30704 (EGG–11265-1087) **Measurement of directional thermal infrared emissivity of vegetation and soils.** Norman, J.M. (Wisconsin Univ., Madison, WI (United States). Dept. of Soil Science); Balick, L.K. EG and G Energy Measurements, Inc., Las Vegas, NV (United States). [1995]. 20p. Sponsored by USDOE,

Washington, DC (United States). DOE Contract AC08-93NV11265. Order Number DE96001125. Source: OSTI; NTIS; GPO Dep.

A new method has been developed for measuring directional thermal emissivity as a function of view angle for plant canopies and soils using two infrared thermometers each sensitive to a different wavelength band. By calibrating the two infrared thermometers to 0.1C consistency, canopy directional emissivity can be estimated with typical errors less than 0.005 in the 8–14 um wavelength band, depending on clarity of the sky and corrections for CO_2 absorption by the atmosphere. A theoretical justification for the method is developed along with an error analysis. Laboratory measurements were used to develop corrections for CO_2, absorption and a field calibration method is used to obtain the necessary 0.1C consistency for relatively low cost infrared thermometers. The emissivity of alfalfa (LAI=2.5) and corn (LAI=3.2) was near 0.995 and independent of view angle. Individual corn leaves had an emissivity of 0.97. A wheat (LAI=3.0) canopy had an emissivity of 0.985 at nadir and 0.975 at 75 degree view angle. The canopy emissivity values tend to be higher than values in the literature, and are useful for converting infrared thermometer measurements to kinetic temperature and interpreting satellite thermal observations.

30705 (EGG–11265-1134) **Influence of physiography and vegetation on small mammals at the Naval Petroleum Reserves, California.** Cypher, B.L. EG and G Energy Measurements, Inc., Tupman, CA (United States). 13 Feb 1995. 22p. Sponsored by USDOE, Washington, DC (United States). DOE Contract AC08-93NV11265. Order Number DE96000169. Source: OSTI; NTIS; GPO Dep.

Influence of physiography and vegetation on small mammal abundance and species Composition was investigated at Naval Petroleum Reserve No. 1 in California to assess prey abundance for Federally endangered San Joaquin kit foxes (Vulpes macrotis mutica) and to assess the distribution of two Federal candidate species, San Joaquin antelope squirrels (Ammospermophilus nelsoni) and short-nosed kangaroo rats (Dinodomys nitratoides brevinasus). The specific objectives of this investigation were to determine whether small mammal abundance and community composition varied with north-south orientation, terrain, ground cover, and Cypher shrub density, and whether these factors influenced the distribution and abundance of San Joaquin antelope squirrels and short-nosed kangaroo rats.

30706 (EGG–11265-2019) **Effects of seed origin and irrigation on survival and growth of transplanted shrubs.** Winkel, V.K. EG and G Energy Measurements, Inc., Las Vegas, NV (United States). Environmental Sciences Div. [1995]. 20p. Sponsored by USDOE, Washington, DC (United States). DOE Contract AC08-93NV11265. (CONF-9506226–1: 12. American Society for Surface Mining and Reclamation annual meeting: decades later - a time for reassessment, Gillette, WY (United States), 3-8 Jun 1995). Order Number DE96000186. Source: OSTI; NTIS; GPO Dep.

Revegetation is difficult in the Mojave Desert due to limited, erratic precipitation and extreme temperatures. Establishing plant cover by transplanting native shrubs is known to be a promising technique, but many questions still remain regarding its use on a large operational scale. A study was initiated on the US Department of Energy Nevada Test Site (NTS) to determine the effects of seed origin and irrigation on survival and growth of transplanted shrubs. Plants of three species (Larrea tridentata, Ambrosia dumosa, and Atriplex canescens) were grown in a greenhouse and hardened outdoors. Plants of all three species were produced from two seed sources: (1) seed collected from the NTS (Mojave Desert), and (2) commercially available seed collected from outside the NTS. One-year-old containerized plants (180 of each species) were transplanted to a site on the NTS and irrigated with two liters of water at one of the following frequencies: (1) at time of planting only, (2) at time of planting and monthly during the first growing season, and (3) at time of planting and twice monthly during the first growing season. After 16 months, survival of all species was generally greater than 80% and was unaffected by irrigation treatments. Survival of fourwing saltbush was significantly greater from local versus non-local seed. Survival of bursage and creosotebush was generally unaffected by seed origin. Shrub volumes regardless of species or seed origin increased during the first growing season, and then decreased during the second growing season. Shrub volumes for fourwing saltbush were significantly greater for shrubs from local versus non-local seed.

30707 (EGG–11265-2047) **Endangered Species Program, Naval Petroleum Reserves in California. Annual report FY93.** EG and G Energy Measurements, Inc., Las Vegas, NV (United States). Las Vegas Area Operations. Feb 1995. 52p. Sponsored by USDOE, Washington, DC (United States). DOE Contract AC08-93NV11265. Order Number DE96000161. Source: OSTI; NTIS; GPO Dep.

The Naval Petroleum Reserves in California (NPRC) are operated by the US Department of Energy (DOE) and Chevron USA. Production Company (CPDN). Four federally-listed endangered animal species and one federally-threatened plant species are known to occur on NPRC: San Joaquin kit fox, blunt-nosed leopard lizard, giant kangaroo rat, Tipton kangaroo rat, and Hoover's wooly-star. All five are protected under the Endangered Species Act of 1973, which declares that it is "...the policy of Congress that all Federal departments and agencies shall seek to conserve endangered species and threatened species and shall utilize their authorities in furtherance of the purposes of the Act." DOE is also obliged to determine whether actions taken by their lessees on Naval Petroleum Reserve No. 2 will have any effects on endangered species or their habitats. The major objective of the EG&G Energy Measurements, Inc. Endangered Species Program on NPRC is to provide DOE with the scientific expertise necessary for compliance with the Endangered Species Act. The specific objective of this report is to summarize progress and results of the Endangered Species Program made during fiscal year 1993.

30708 (GSF–24/94) **AUTOPARK and DOSISPARK. Two modules of the software system for assessment and mitigation of radionuclide deposition and its effects.** Gregor, J.; Bleher, M.; Stapel, R.; Jakob, P.; Eklund, J.; Luczak-Ulrik, D. GSF - Forschungszentrum fuer Umwelt und Gesundheit Neuherberg GmbH, Oberschleissheim (Germany). Inst. fuer Strahlenschutz. Sep 1994. 258p. (In German). Sponsored by Bundesministerium fuer Umwelt, Naturschutz und Reaktorsicherheit, Bonn (Germany). Contract BMU St.Sch. 1073; Foerderkennzeichen BMU St.Sch. 4023. Order Number DE96706554. Source: OSTI; NTIS (US Sales Only); INIS.

The PARK software system as a part of the IMIS system performs the processing of the measured ambient radioactivity data so as to allow full-scale analyses to be made of the topical radiological situation across Germany, or prospective analyses. The PARK data are intended to serve as the database for large-area ambient radioactivity assessment in the event of a radiological emergency, and as a basis for decisions to be taken for remedial action and recommended protective provisions. The software system relies essentially on the dynamic food chain model called ECOSYS-87, and comprises the sub-systems AUTOPARK, DIAPARK, and DOSISPARK. The core system is the largely automated sub-system AUTOPARK which at highest performance level of the entire IMIS system, as provided for in section 2 of the Preventive Radiation Protection Act, (StrVG), processes the measured data of the federal monitoring stations, and the results of the atmospheric dispersion computations contributed by the German Weather Service. In the event of a radiological emergency, AUTOPARK delivers the data for fast assessment of the given and prospective contamination of essential agricultural produce and of the radiation dose to the population, as well as data for assessment of the effects achieved by remedial action. DOSISPARK is the module applied in routine operation of the IMIS system for assessment of radiation doses to the population. The report explains the procedure for routine dose calculations and the permanent data base (as e.g. dose coefficients) maintained for this purpose, which also is available for emergency data processing with the AUTOPARK module. DIAPARK is a dialog-controlled software system. It allows analysis of specific problems in the wake of an emergency, as for example changes in the composition of animal feed, on the basis of data delivered by AUTOPARK, indicating the nuclide deposition and accumulation in soil and vegetation. (orig./HP)

30709 (IC–95/104) **The updated Vrancea seismoactive region catalog.** Moldoveanu, C.L. (International Centre for Theoretical Physics, Trieste (Italy)); Novicova, O.V.; Vorobieva, I.A.; Popa, M. International Centre for Theoretical Physics, Trieste (Italy). Jun 1995. 68p. Order Number DE96601754. Source: OSTI; NTIS (US Sales Only); INIS.

Vrancea seismoactive region is placed between 45.0N-46.0N and 26.0E-27.0E, Romania, and is characterized by a relatively small size for the focal volume and a high level of the intermediate-depth seismic activity. In order to apply the intermediate-term earthquake prediction CN algorithm a catalog was compiled from three Romanian catalogs and a Russian catalog. It covers the period 1932.01.01-1995.04.01. 5 refs, 2 figs.

30710 (INEL–95/0101) **A preliminary survey of the National Wetlands Inventory as mapped for the Idaho National Engineering Laboratory.** Hampton, N.L.; Rope, R.C.; Glennon, J.M.; Moor, K.S. EG and G Idaho, Inc., Idaho Falls, ID (United States). Feb 1995. 80p. Sponsored by USDOE, Washington, DC (United States). DOE Contract AC07-94ID13223. Order Number DE96001355. Source: OSTI; NTIS; INIS; GPO Dep.

Approximately 135 areas within the boundaries of the Idaho National Engineering Laboratory (INEL) have been mapped as wetland habitat as part of the United States Fish and Wildlife Service (FWS) National Wetlands Inventory (NWI). A preliminary survey of these wetlands was conducted to examine their general characteristics and status, to provide an estimation of relative ecological importance, to identify additional information needed to complete ecological characterization of important INEL wetlands, and to identify high priority wetland areas on the INEL. The purpose of the survey was to provide information to support the preparation of the Environmental Restoration and Waste Management (ER&WM) Environmental Impact Statement (EIS). Information characterizing general vegetation, hydrology, wildlife use, and archaeology was collected at 105 sample sites on the INEL. Sites representing NWI palustrine, lacustrine, and riverine wetlands (including manmade), and areas unmapped or unclassified by the NWI were included in the sample. The field information was used to develop a preliminary ranking of relative ecological importance for each wetland visited during this survey. Survey limitations are identified.

30711 (INEL–95/0132(94)) **Environmental surveillance for Waste Management Facilities at the Idaho National Engineering Laboratory. Annual report 1994.** Wright, K.C.; Wilhelmsen, R.N.; Borsella, B.W.; Miles, M. Lockheed Idaho Technologies Co., Idaho Falls, ID (United States). Aug 1995. 100p. Sponsored by USDOE, Washington, DC (United States). DOE Contract AC07-94ID13223. Order Number DE95017523. Source: OSTI; NTIS; INIS; GPO Dep.

This report describes calendar year 1994 environmental surveillance activities of Environmental Monitoring of Lockheed Martin Idaho Technologies, performed at Waste Management Facilities at the Idaho National Engineering Laboratory (INEL). The major facilities monitored include the Radioactive Waste Management Complex, the Waste Experimental Reduction Facility, the Mixed Waste Storage Facility, and two surplus facilities. Included are results of the sampling performed by the Radiological Environmental Surveillance Program, INEL Environmental Surveillance Program, and the United States Geological Survey. The primary purposes of monitoring are to evaluate environmental conditions, to provide and interpret data, to ensure compliance with applicable regulations or standards, and to ensure protection of human health and the environment. This report compares 1994 environmental surveillance data with US Department of Energy derived concentration guides and with data from previous years.

30712 (INIS-BR–3551) **Obsidian dating by fission track method.** Araya, A.M.O. Universidade Estadual de Campinas, SP (Brazil). Inst. de Fisica. Dec 1990. 100p. (In Portuguese). Order Number DE96602581. Source: OSTI; NTIS; INIS.

The fission track method was employed to obtain the age of twelve obsidian sample from Ecuador. By using the plateau-age correction method, we obtained the true age of each sample and were able to identify four groups of ages in the studied area. Thereafter we studied the fading of fission tracks in two obsidian samples with different origins: Yanaurcu, Ecuador and Monte Arci, Italy. We constructed Arrhenius plots and calculated activation energies for both samples. The results from thermal annealing experiments were compared with theoretical curves obtained by integrating an equation proposed by Shukolyukov et al (1965). (author). 43 refs, 20 figs, 10 tabs.

30713 (IS–5117) **Zero-tension lysimeters: An improved design to monitor colloid-facilitated contaminant transport in the vadose zone.** Thompson, M.L.; Scharf, R.L.; Shang, C. Ames Lab., IA (United States). 24 Apr 1995. 46p. Sponsored by USDOE, Washington, DC (United States). DOE Contract W-7405-ENG-82. Order Number DE96000214. Source: OSTI; NTIS; INIS; GPO Dep.

There is increasing evidence that mobile colloids facilitate the long-distance transport of contaminants. The mobility of fine particles and macromolecules has been linked to the movement of actinides, organic contaminants, and heavy metals through soil. Direct evidence for colloid mobility includes the presence of humic materials in deep aquifers as well as coatings of accumulated clay, organic matter, or sesquioxides on particle or aggregate surfaces in subsoil horizons of many soils. The potential for colloid-facilitated transport of contaminants from hazardous-waste sites requires adequate monitoring before, during, and after in-situ remediation treatments. Zero-tension lysimeters (ZTLs) are especially appropriate for sampling water as it moves through saturated soil, although some unsaturated flow events may be sampled as well. Because no ceramic barrier or fiberglass wick is involved to maintain tension on the water (as is the case with other lysimeters), particles suspended in the water as well as dissolved species may be sampled with ZTLs. In this report, a ZTL design is proposed that is more suitable for monitoring colloid-facilitated contaminant migration. The improved design consists of a cylinder made of polycarbonate or polytetrafluoroethylene (PTFE) that is placed below undisturbed soil material. In many soils, a hydraulically powered tube may be used to extract an undisturbed core of soil before placement of the lysimeter. In those cases, the design has significant advantages over conventional designs with respect to simplicity and speed of installation. Therefore, it will allow colloid-facilitated transport of contaminants to be monitored at more locations at a given site.

30714 (JAERI-Research–95-044) **Effects of drying on desorption behavior of radionuclides adsorbed on a sand.** Tanaka, Tadao (Japan Atomic Energy Research Inst., Tokai, Ibaraki (Japan). Tokai Research Establishment). Japan Atomic Energy Research Inst., Tokyo (Japan). Jun 1995. 26p. (In Japanese). Order Number DE96701327. Source: OSTI; NTIS; INIS.

In order to study on adsorption and desorption behavior of radionuclide in a natural aerated soil layer repeated a cycle of rainfall and evaporation, desorption experiments of ^{60}Co, ^{85}Sr and ^{137}Cs adsorbed on a coastal sand have been performed by a batch method, in which a drying and an elution with deionized water were repeated. Desorption ratios of the three radionuclides to the sorbed ones were not affected by the drying period. The desorption ratios of ^{85}Sr and ^{137}Cs under the discontinuous elution cycled drying and elution were larger than that under the continuous elution, while no differences in the desorption ratio of ^{60}Co were observed between both the elution procedures. The sand surface was weathered under the discontinuous elution, so that some ions and fine soil particles were dissociated from the sand into the eluents. Increase of the desorption ratios of ^{85}Sr and ^{137}Cs under the discontinuous elution could be attributable to a degradation of the sand surface during contact period with water and to a generation of the fine soil particles fixed ^{137}Cs. (author).

30715 (JAERI-Review–95-011) **Geochemical studies for geologic disposal of high-level radioactive waste. Research activities in Department of Environmental Safety Research, Japan Atomic Energy Research Institute.** Nakayama, Shinichi (Japan Atomic Energy Research Inst., Tokai, Ibaraki (Japan). Tokai Research Establishment); Sato, Tsutomu; Nagano, Tetsushi; Yanase, Nobuyuki; Yamaguchi, Tetsuji; Isobe, Hiroshi; Ohnuki, Toshihiko; Sekine, Keiichi. Japan Atomic Energy Research Inst., Tokyo (Japan). Jul 1995. 103p. (In Japanese). Order Number DE96701390. Source: OSTI; NTIS; INIS.

The Environmental Geochemistry Laboratory of the Department of Environmental Safety Research of JAERI (EGL/JAERI) is responsible for performing fundamental research to support the geologic disposal of high-level radioactive waste and the performance

assessment of the disposal concept. This research includes basic laboratory experiments as well as field studies of natural analogs to understand the geochemical behavior of radionuclides, i.e., the interactions between radionuclides, groundwater and geological materials. This report summarizes background, objectives and recent results of the scientific investigations and emphasizes the significance of these studies in terms of both fundamental research on geochemistry and applied research for performance assessment of the waste disposal concept. The importance of performing fundamental research to radioactive waste disposal is stressed in this report. The report is aimed at both the radioactive waste disposal scientific community and the interdisciplinary sciences that interact with this community. (author).

30716 (KCP–613-5602) **Evaluation of micropurging versus traditional groundwater sampling at the Department of Energy's Kansas City Plant.** Stites, M.E. (Allied Signal Inc., Kansas City, MO (United States)); Baker, J.L.; Kearl, P.M. Allied-Signal Aerospace Co., Kansas City, MO (United States). Kansas City Div. Aug 1995. 10p. Sponsored by USDOE, Washington, DC (United States). DOE Contract AC04-76DP00613. (CONF-950868–14: Environmental remediation conference: committed to results, Denver, CO (United States), 13-18 Aug 1995). Order Number DE95017314. Source: OSTI; NTIS; GPO Dep.

A field trial comparing the micropurge and the traditional purge and sample method of groundwater sampling was conducted at the U.S. Department of Energy (DOE), Kansas City Plant (KCP) in 1993 and 1994. Duplicate groundwater samples were collected using traditional and micropurge methods, analyzed for selected organic and inorganic constituents, and the results compared statistically. Evaluation of the data using the Wilcoxon Sign Rank test indicates that within a 95% confidence interval, there was no significant difference between the two methods for the site contaminants and the majority of naturally occurring analytes. These analytical results were supported by visual observations with the colloidal borescope, which demonstrated impacts on the flow system in the well when using traditional sampling methods. Under selected circumstances, the results suggest replacing traditional sampling with micropurging based on reliability, cost, and waste minimization.

30717 (LA–12912-MS) **Environmental geochemistry for surface and subsurface waters in the Pajarito Plateau and outlying areas, New Mexico.** Blake, W.D.; Goff, F.; Adams, A.I.; Counce, D. Los Alamos National Lab., NM (United States). May 1995. 47p. Sponsored by USDOE, Washington, DC (United States). DOE Contract W-7405-ENG-36. Order Number DE95015015. Source: OSTI; NTIS; GPO Dep.

This report provides background information on waters in the Los Alamos and Santa Fe regions of northern New Mexico. Specifically, the presented data include major element, trace element, and isotope analyses of 130 water samples from 94 different springs, wells, and water bodies in the area. The region considered in this study extends from the western edge of the Valles Caldera to as far east as Santa Fe Lake. For each sample, the presented analysis includes fourteen different major elements, twenty-six trace elements, up to five stable isotopes, and tritium. In addition, this data base contains certain characteristics of the water that are calculated from the aforementioned raw data, including the water's maximum and minimum residence times, as found from tritium levels assuming no contamination, the water's recharge elevation, as found from stable isotopes, and the charge balance of the water. The data in this report are meant to provide background information for investigations in groundwater hydrology and geochemistry, and for environmental projects. For the latter projects, the presented information would be useful for determining the presence of contamination it any one location by enabling one to compare potential contaminant levels to the background levels presented here. Likely locations of interest are those possibly effected by anthropogenic activities, including locations in and around Los Alamos National Laboratory, White Rock Canyon, and developed areas in the Rio Grande Valley.

30718 (LA–12968-MS) **The unsaturated hydraulic characteristics of the Bandelier Tuff.** Rogers, D.B.; Gallaher, B.M. Los Alamos National Lab., NM (United States). Sep 1995. 138p. Sponsored by USDOE, Washington, DC (United States). DOE Contract W-7405-ENG-36. Order Number DE96000894. Source: OSTI; NTIS; GPO Dep.

Report includes diskette designed to run on IBM PC compatible equipment.

This report summarizes the physical and, unsaturated hydraulic properties of the Bandelier Tuff determined from laboratory measurements made on core samples collected at Los Alamos National Laboratory. We fit new van Genuchten-type moisture retention curves to this data, which was categorized according to member of the Bandelier Tuff and subunit of the Tshirege Member. Reasonable consistency was observed for hydraulic properties and retention curves within lithologic units, while distinct differences were observed for those properties between units. With the moisture retention data, we constructed vertical profiles of in situ matric suction and hydraulic head. These profiles give an indication of the likely direction of liquid water movement within the unsaturated zone and allow comparison of core-scale and field-scale estimates of water flow and solute transport parameters. Our core-derived transport velocities are much smaller than values estimated from tritium, Cl, and NO_3 contamination found recently in boreholes. The contaminant tracer-derived transport velocities from Los Alamos Canyon are greater than corederived values found for the Otowi Member, and for Mortandad Canyon, greater than core-derived values for that borehole. The significant difference found for Mortandad Canyon suggests that fracture or other fast-path transport may be important there. The relatively small difference between observed and predicted velocities at Los Alamos Canyon may mean that vadose zone transport there occurs by unsaturated matrix flow.

30719 (LA–13036-MS) **Joint orientation and characteristics as observed in a trench excavated near TA-3 and a basement excavated at TA-55.** Purtymun, W.D.; Koenig, E.; Morgan, T.; Sagon, E. Los Alamos National Lab., NM (United States). Oct 1995. 42p. Sponsored by USDOE, Washington, DC (United States). DOE Contract W-7405-ENG-36. Order Number DE96000885. Source: OSTI; NTIS; GPO Dep.

Walls of excavations in the Bandelier Tuff for pipelines and foundations for structures provide excellent areas to determine the orientation (strike and dip) and characteristics of the joints (frequency, width, and type of material filling the joint). Joints or fractures are commonly associated with structural adjustments such as faulting; however, joints formed in the tuff mainly result from the shrinkage of the ash-flow tuff as it cools. The presence of faults can restrict the siting of buildings or structures. In waste disposal operations, open joints can be pathways for the transport of contaminants.

30720 (LA-SUB–95-177) **Spectroscopic studies of U(VI) sorption at the kaolinite-water interface. Final report.** Thompson, H.A.; Parks, G.A.; Brown, G.E. Jr. Los Alamos National Lab., NM (United States). 1 Jun 1994. 125p. Sponsored by USDOE, Washington, DC (United States). DOE Contract W-7405-ENG-36. Order Number DE96000862. Source: OSTI; NTIS; INIS; GPO Dep.

Efficient use of U as a resource and safe handling, recycling and disposal of U-containing wastes require an understanding of the factors controlling the fate of U, where fate refers to the destination of U, typically expressed as an environmental medium or a process phase. The sorption process constitutes a change in elemental fate. Partitioning of an element from solution to a solid phase, or sorption, can be divided into three broad categories: adsorption, surface precipitation, and absorption. Extended X-ray absorption fine structure (EXAFS), a type of X-ray absorption spectroscopy (XAS), offers the possibility for distinguishing among different modes of sorption by characterizing the atomic environment of the sorbing element. In this study, the authors use EXAFS to determine the structure of U(VI) sorption complexes at the kaolinite-water interface. In Chapter One, they present an overview of selected aspects of U structural chemistry as a basis for considering the structural environment of U at the solid-water interface. To evaluate the utility of XAS for characterization of the structural environment of U(VI) at the solid-water interface, they have carried out an in-depth analysis of XAS data from U(VI)-containing solid and solution model compounds, which they describe in Chapter Two. In Chapter three, they consider sorption of U by kaolinite as a

means of effecting the removal of U from surface collection pond waters on the Rocky Flats Plant site in northern Colorado.

30721 (LA-UR–95-1828) **A repository released-dose model for the evaluation of long-lived fission product transmutation effectiveness.** Davidson, J.W. Los Alamos National Lab., NM (United States). [1995]. 16p. Sponsored by USDOE, Washington, DC (United States). DOE Contract W-7405-ENG-36. (CONF-9509162–6: Global '95, Versailles (France), 11 Sep 1995). Order Number DE95015308. Source: OSTI; NTIS; INIS; GPO Dep.

A methodology has been developed to quantify the total integrated dose due to a radionuclide species i emplaced in a geologic repository; the focus is on the seven long-lived fission products (LLFPs). The methodology assumes continuous exposure water contaminated with species i at the accessible environment (i.e., just beyond the geologic barrier afforded by the geologic repository). The dose integration is performed out to a reference post-release time. The integrated dose is a function of the total initial inventory of radionuclide i the repository, the time at which complete and instantaneous failure of the engineered barrier (e.g., waste canister) in, a geologic repository occurs, the fractional dissolution rate (from waste solid form) of radionuclide i in ground water, the ground water travel time to the accessible environment, the retardation factor (sorption on the geologic media) for radionuclide i, the time after radionuclide begins to enter the biosphere. In order to assess relative dose, the ratio of total integrated dose to that for a reference LLFP species j (e.g., ^{99}Tc) was defined. This ratio is a measure of the relative benefit of transmutation of other LLFPs compared to ^{99}Tc. This methodology was further developed in order to quantify the integrated dose reduction per neutron utilized for LLFP transmutation in accelerator-driven transmutation technologies (ADTT). This measure of effectiveness is a function of the integrated dose due to LLFP species i, the number of total captures in LLFP species i chain per LLFP nuclide fed to the chain at equilibrium, and the number of total captures in related transmutation product (TP) chains per capture in the LLFP species i chain. To assess relative transmutation effectiveness, the ratio of integrated dose reduction per neutron utilization to that for a reference LLFP species j (e.g., ^{99}Tc) was defined. This relative measure of effectiveness was evaluated LLFP transmutation strategy.

30722 (LA-UR–95-2707) **Scale up of flow in porous media.** An, L. (State Univ. of New York, Stony Brook, NY (United States)); Glimm, J.; Zhang, Q.; Zhang, Q. Los Alamos National Lab., NM (United States); State Univ. of New York, Stony Brook, NY (United States). [1995]. 16p. Sponsored by USDOE, Washington, DC (United States);Department of Defense, Washington, DC (United States);National Science Foundation, Washington, DC (United States);Cornell Univ., Ithaca, NY (United States). DOE Contract W-7405-ENG-36 ; FG02-90ER25084. Grant DAAL03-92-G-0185; Contract DAAL03-91-C-0027; Grant DMS-920 (CONF-9505272–1: 7. international conference on fluid flow in porous media, St. Etienne (France), May 1995). Order Number DE95016948. Source: OSTI; NTIS; GPO Dep.

The authors study the scale up problem for flow in porous media. The general nature of this problem is outlined, leading to a discussion of assumptions on random fields appropriate for the description of geological heterogeneities. The main point of this paper is to use direct numerical simulation to evaluate the ensemble averages describing fluid dispersion, for flow in porous media. The relation between ensemble dispersion and single realization dispersion is discussed in the case of linear transport, and the role of plume or channel width is also explored. Finally, they consider nonlinear transport, and contrast dispersive to hyperbolic renormalization of the flow equations. For the geological and fluid parameters considered here, the hyperbolic renormalization is trivial, indicating that dispersive renormalization is appropriate in these cases. Further study of the ideas explored in this paper will be required for a proper understanding of their role in a more complete theory which the authors hope will follow.

30723 (LBL–35738) **Implementation of a new algorithm for Density Equalizing Map Projections (DEMP).** Close, E.R.; Merrill, D.W.; Holmes, H.H. Lawrence Berkeley Lab., CA (United States). Jul 1995. 134p. Sponsored by USDOE, Washington, DC (United States). DOE Contract AC03-76SF00098. Order Number DE96000873. Source: OSTI; NTIS; GPO Dep.

The purpose of the PAREP (Populations at Risk to Environmental Pollution) Project at Lawrence Berkeley National Laboratory (LBNL), an ongoing Department of Energy (DOE) project since 1978, is to develop resources (data, computing techniques, and biostatistical methodology) applicable to DOE's needs. Specifically, the PAREP project has developed techniques for statistically analyzing disease distributions in the vicinity of supposed environmental hazards. Such techniques can be applied to assess the health risks in populations residing near DOE installations, provided adequate small-area health data are available. The FY 1994 task descriptions for the PAREP project were determined in discussions at LBNL on 11/2/93. The FY94 PAREP Work Authorization specified three major tasks: a prototype small area study, a feasibility study for obtaining small-area data, and preservation of the PAREP data archive. The complete FY94 work plan, and the subtasks accomplished to date, were included in the Cumulative FY94 progress report.

30724 (LBL–37200, pp. 163-168) **Predicting the distribution of contamination from a chlorinated hydrocarbon release.** Lupo, M.J. (K.W. Brown Environmental Services, College Station, TX (United States)); Moridis, G.J. Lawrence Berkeley Lab., CA (United States). Mar 1995. DOE Contract AC03-76SF00098. (CONF-9503110–: TOUGH 95: transport of unsaturated ground water and heat workshop, Berkeley, CA (United States), 20-22 Mar 1995). In *Proceedings of the TOUGH Workshop '95 Lawrence Berkeley Laboratory, Berkeley, California, March 20–22, 1995.* 380p. Order Number DE95014788. Source: OSTI; NTIS; GPO Dep.

The T2VOC model with the T2CG1 conjugate gradient package was used to simulate the motion of a dense chlorinated hydrocarbon plume released from an industrial plant. The release involved thousands of kilograms of trichloroethylene (TCE) and other chemicals that were disposed of onsite over a period of nearly twenty years. After the disposal practice ceased, an elongated plume was discovered. Because much of the plume underlies a developed area, it was of interest to study the migration history of the plume to determine the distribution of the contamination.

30725 (LBL–37200, pp. 169-174) **LNAPL infiltration in the vadose zone: Comparisons of physical and numerical simulations.** Pantazidou, M. (Carnegie Mellon Univ., Pittsburgh, PA (United States)). Lawrence Berkeley Lab., CA (United States). Mar 1995. DOE Contract AC03-76SF00098. (CONF-9503110–: TOUGH 95: transport of unsaturated ground water and heat workshop, Berkeley, CA (United States), 20-22 Mar 1995). In *Proceedings of the TOUGH Workshop '95 Lawrence Berkeley Laboratory, Berkeley, California, March 20–22, 1995.* 380p. Order Number DE95014788. Source: OSTI; NTIS; GPO Dep.

The numerical model T2VOC was used to reproduce light, nonaqueous phase liquid (LNAPL) infiltration scenarios in the vadose zone. The numerical modeling results were compared to results from laboratory experiments simulating LNAPL spills in the vadose zone. Laboratory measurements included results from one-dimensional column and two-dimensional tank experiments using uniform sands of varying average grain sizes. The constitutive relationships for the sands were obtained from the one-dimensional experiments. The two-dimensional experiments simulated leakage of kerosene under constant head. The sensitivity of the numerical results to the constitutive relationships used and the specified boundary conditions was examined. For this purpose two different capillary pressure-saturation relationships were used for the same sand and both constant head and constant flux conditions were obtained for the two capillary pressure curves used. The constant flux boundary conditions produced a much better prediction. At the initial stages of infiltration the results for both capillary pressure curves were similar and in good agreement with the experimental results. However, as the LNAPL front approaches the capillary fringe the choice of the capillary pressure curve was found to influence the results.

30726 (LBL–37200, pp. 181-186) **Using simulation-optimization techniques to improve multiphase aquifer remediation.** Finsterle, S. (Lawrence Berkeley Laboratory, Berkeley, CA (United States)); Pruess, K. Lawrence Berkeley Lab., CA

(United States). Mar 1995. DOE Contract AC03-76SF00098. (CONF-9503110–: TOUGH 95: transport of unsaturated ground water and heat workshop, Berkeley, CA (United States), 20-22 Mar 1995). In *Proceedings of the TOUGH Workshop '95 Lawrence Berkeley Laboratory, Berkeley, California, March 20–22, 1995.* 380p. Order Number DE95014788. Source: OSTI; NTIS; GPO Dep.

The T2VOC computer model for simulating the transport of organic chemical contaminants in non-isothermal multiphase systems has been coupled to the ITOUGH2 code which solves parameter optimization problems. This allows one to use linear programming and simulated annealing techniques to solve groundwater management problems, i.e. the optimization of operations for multiphase aquifer remediation. A cost function has to be defined, containing the actual and hypothetical expenses of a cleanup operation which depend - directly or indirectly - on the state variables calculated by T2VOC. Subsequently, the code iteratively determines a remediation strategy (e.g. pumping schedule) which minimizes, for instance, pumping and energy costs, the time for cleanup, and residual contamination. We discuss an illustrative sample problem to discuss potential applications of the code. The study shows that the techniques developed for estimating model parameters can be successfully applied to the solution of remediation management problems. The resulting optimum pumping scheme depends, however, on the formulation of the remediation goals and the relative weighting between individual terms of the cost function.

30727 (LBL–37200, pp. 187-192) **Soil remediation by heat injection: Experiments and numerical modelling.** Betz, C. (Univ. of Stuttgart (Germany)); Emmert, M.; Faerber, A. Lawrence Berkeley Lab., CA (United States). Mar 1995. DOE Contract AC03-76SF00098. (CONF-9503110–: TOUGH 95: transport of unsaturated ground water and heat workshop, Berkeley, CA (United States), 20-22 Mar 1995). In *Proceedings of the TOUGH Workshop '95 Lawrence Berkeley Laboratory, Berkeley, California, March 20–22, 1995.* 380p. Order Number DE95014788. Source: OSTI; NTIS; GPO Dep.

In order to understand physical processes of thermally enhanced soil vapor extraction methods in porous media the isothermal, multiphase formulation for the numerical model MUFTE will be extended by a non-isothermal, multiphase-multicomponent formulation. In order to verify the numerical model, comparison with analytical solutions for well defined problems will be carried out. To identify relevant processes and their interactions, the results of the simulation will be compared with well controlled experiments with sophisticated measurement equipment in three different scales. The aim is to compare the different numerical solution techniques namely Finite Element versus Integral Finite Difference technique as implemented in MUFTE and TOUGH2 [9] respectively.

30728 (LBL–37200, pp. 193-198) **Numerical simulation of in-situ DNAPL remediation by alcohol flooding.** Falta, R.W. (Earth Science Department, Clemson, SC (United States)); Brame, S.E. Lawrence Berkeley Lab., CA (United States). Mar 1995. DOE Contract AC03-76SF00098. (CONF-9503110–: TOUGH 95: transport of unsaturated ground water and heat workshop, Berkeley, CA (United States), 20-22 Mar 1995). In *Proceedings of the TOUGH Workshop '95 Lawrence Berkeley Laboratory, Berkeley, California, March 20–22, 1995.* 380p. Order Number DE95014788. Source: OSTI; NTIS; GPO Dep.

The removal of residual saturations of dense non-aqueous phase liquids (DNAPLs) from below the water table using alcohol solutions is under investigation as a potential remediation tool. Alcohol flooding reduces the interfacial tension (IFT) an density difference between the aqueous and DNAPL phases, and increases the chemical solubility in the aqueous phase. Depending on the partitioning behavior of the alcohol/chemical system, DNAPL can be removed by either mobilization as a separate phase or through enhanced dissolution. A new three dimensional multiphase numerical simulator has been developed for modeling this process. The code is based on the general TOUGH2 Integral Finite Difference formulation for multiphase transport with modifications to account for the complex behavior of an alcohol/water/DNAPL system. The alcohol flood code uses a special equation of state module for computing phase compositions, IFT, saturations, densities, viscosities, relative permeabilities, and capillary pressures during each time step. This equation of state is based on a numerical interpolation of experimentally determined ternary phase data. The code was designed so that it can readily be applied to other three-component, two-phase problems such as surfactant and solvent floods given appropriate ternary data. Comparisons of simulation results with column experiments performed at Clemson University were used to validate the simulator.

30729 (LBL–37200, pp. 205-210) **Strongly coupled single-phase flow problems: Effects of density variation, hydrodynamic dispersion, and first order decay.** Oldenburg, C.M. (Lawrence Berkeley Laboratory, Berkeley, CA (United States)); Pruess, K. Lawrence Berkeley Lab., CA (United States). Mar 1995. DOE Contract AC03-76SF00098. (CONF-9503110–: TOUGH 95: transport of unsaturated ground water and heat workshop, Berkeley, CA (United States), 20-22 Mar 1995). In *Proceedings of the TOUGH Workshop '95 Lawrence Berkeley Laboratory, Berkeley, California, March 20–22, 1995.* 380p. Order Number DE95014788. Source: OSTI; NTIS; GPO Dep.

We have developed TOUGH2 modules for strongly coupled flow and transport that include full hydrodynamic dispersion. T2DM models tow-dimensional flow and transport in systems with variable salinity, while T32DMR includes radionuclide transport with first-order decay of a parent-daughter chain of radionuclide components in variable salinity systems. T2DM has been applied to a variety of coupled flow problems including the pure solutal convection problem of Elder and the mixed free and forced convection salt-dome flow problem. In the Elder and salt-dome flow problems, density changes of up to 20% caused by brine concentration variations lead to strong coupling between the velocity and brine concentration fields. T2DM efficiently calculates flow and transport for these problems. We have applied T2DMR to the dispersive transport and decay of radionuclide tracers in flow fields with permeability heterogeneities and recirculating flows. Coupling in these problems occurs by velocity-dependent hydrodynamic dispersion. Our results show that the maximum daughter species concentration may occur fully within a recirculating or low-velocity region. In all of the problems, we observe very efficient handling of the strongly coupled flow and transport processes.

30730 (LBL–37200, pp. 211-217) **Air sparging for subsurface remediation: Numerical analysis using T2VOC.** McCray, J.E. (Clemson Univ. SC (United States)); Falta, R.W. Lawrence Berkeley Lab., CA (United States). Mar 1995. DOE Contract AC03-76SF00098. (CONF-9503110–: TOUGH 95: transport of unsaturated ground water and heat workshop, Berkeley, CA (United States), 20-22 Mar 1995). In *Proceedings of the TOUGH Workshop '95 Lawrence Berkeley Laboratory, Berkeley, California, March 20–22, 1995.* 380p. Order Number DE95014788. Source: OSTI; NTIS; GPO Dep.

Air sparging is under active investigation as a promising remediation technology for aquifers contaminated with folatile organic dense nonaqueous phase liquids (DNAPLs). A theoretical study for the removal of DNAPLs from the subsurface using this technology is presented. T2VOC is used to conduct multiphase numerical simulations of DNAPL removal utilizing a model aquifer with a radially-symmetric geometry. Both homogeneous and macroscale heterogeneous systems are considered. These simulations suggest that DNAPLs are efficiently removed in a zone of contaminant cleanup at relatively low gas saturations within the injected air plume. The zone of effective removal may be referred to as the radius of influence (ROI). The sparging-induced pressure increase below the water table, which may be measured in the field, is recommended as the best method for determining the ROI. Multiphase numerical simulations are used to support this recommendation, to relate the injected gas ROI to the zone of NAPL cleanup, and to illustrate the transient and steady-state aquifer behavior.

30731 (LBL–37200, pp. 218-220) **Verification of T2VOC using an analytical solution for VOC transport in vadose zone.** Shan, C. (Lawrence Berkeley Laboratory, Berkeley, CA (United States)). Lawrence Berkeley Lab., CA (United States). Mar 1995. DOE Contract AC03-76SF00098. (CONF-9503110–: TOUGH 95: transport of unsaturated ground water and heat workshop, Berkeley, CA (United States), 20-22 Mar 1995). In *Proceedings of the TOUGH Workshop '95 Lawrence Berkeley Laboratory, Berkeley,*

California, March 20–22, 1995. 380p. Order Number DE95014788. Source: OSTI; NTIS; GPO Dep.

T2VOC represents an adaption of the STMVOC to the TOUGH2 environment. In may contaminated sites, transport of volatile organic chemicals (VOC) is a serious problem which can be simulated by T2VOC. To demonstrate the accuracy and robustness of the code, we chose a practical problem of VOC transport as the test case, conducted T2VOC simulations, and compared the results of T2VOC with those of an analytical solution. The agreements between T2VOC and the analytical solutions are excellent. In addition, the numerical results of T2VOC are less sensitive to grid size and time step to a certain extent.

30732 (LBL–37200, pp. 221-225) **Numerical simulations of multicomponent evaporation and gas-phase transport using M^{2}NOTS.** Ho, C.K. (Sandia National Laboratories, Albuquerque, NM (United States)). Lawrence Berkeley Lab., CA (United States). Mar 1995. DOE Contract AC03-76SF00098. (CONF-9503110–: TOUGH 95: transport of unsaturated ground water and heat workshop, Berkeley, CA (United States), 20-22 Mar 1995). In *Proceedings of the TOUGH Workshop '95 Lawrence Berkeley Laboratory, Berkeley, California, March 20–22, 1995.* 380p. Order Number DE95014788. Source: OSTI; NTIS; GPO Dep.

The multiphase, multicomponent, non-isothermal simulator M^{2}NOTS was tested against several one-dimensional experiments. The experiments represented a through-flow limiting condition of soil venting in which air flows through the contaminated region. Predictions using M^{2}NOTS of changing in situ compositions and effluent concentrations for toluene and o-xylene mixtures were compared to the observed results. Results showed that M^{2}NOTS was able to capture the salient trends and features of multicomponent through-flow venting processes.

30733 (LBL–37200, pp. 226) **The effect of vadose zone heterogeneities on vapor phase migration and aquifer contamination by volatile organics.** Seneviratne, A. (Bechtel Corporation, San Francisco, CA (United States)); Findikakis, A.N. Lawrence Berkeley Lab., CA (United States). Mar 1995. DOE Contract AC03-76SF00098. (CONF-9503110–: TOUGH 95: transport of unsaturated ground water and heat workshop, Berkeley, CA (United States), 20-22 Mar 1995). In *Proceedings of the TOUGH Workshop '95 Lawrence Berkeley Laboratory, Berkeley, California, March 20–22, 1995.* 380p. Order Number DE95014788. Source: OSTI; NTIS; GPO Dep.

Organic vapors migrating through the vadose zone and interphase transfer can contribute to the contamination of larger portions of aquifers than estimated by accounting only for dissolved phase transport through the saturated zone. Proper understanding of vapor phase migration pathways is important for the characterization of the extent of both vadose zone and the saturated zone contamination. The multiphase simulation code T2VOC is used to numerically investigate the effect of heterogeneties on the vapor phase migration of chlorobenzene at a hypothetical site where a vapor extraction system is used to remove contaminants. Different stratigraphies consisting of alternate layers of high and low permeability materials with soil properties representative of gravel, sandy silt and clays are evaluated. The effect of the extent and continuity of low permeability zones on vapor migration is evaluated. Numerical simulations are carried out for different soil properties and different boundary conditions. T2VOC simulations with zones of higher permeability were made to assess the role of how such zones in providing enhanced migration pathways for organic vapors. Similarly, the effect of the degree of saturation of the porous medium on vapor migration was for a range of saturation values. Increased saturation reduces the pore volume of the medium available for vapor diffusion. Stratigraphic units with higher aqueous saturation can retard the vapor phase migration significantly.

30734 (LBL–37200, pp. 259-264) **A new lumped-parameter approach to simulating flow processes in unsaturated dual-porosity media.** Zimmerman, R.W. (Lawrence Berkeley Laboratory, CA (United States)); Hadgu, T.; Bodvarsson, G.S. Lawrence Berkeley Lab., CA (United States). Mar 1995. DOE Contract AC03-76SF00098. (CONF-9503110–: TOUGH 95: transport of unsaturated ground water and heat workshop, Berkeley, CA (United States), 20-22 Mar 1995). In *Proceedings of the TOUGH Workshop '95 Lawrence Berkeley Laboratory, Berkeley, California, March 20–22, 1995.* 380p. Order Number DE95014788. Source: OSTI; NTIS; GPO Dep.

We have developed a new lumped-parameter dual-porosity approach to simulating unsaturated flow processes in fractured rocks. Fluid flow between the fracture network and the matrix blocks is described by a nonlinear equation that relates the imbibition rate to the local difference in liquid-phase pressure between the fractures and the matrix blocks. This equation is a generalization of the Warren-Root equation, but unlike the Warren-Root equation, is accurate in both the early and late time regimes. The fracture/matrix interflow equation has been incorporated into a computational module, compatible with the TOUGH simulator, to serve as a source/sink term for fracture elements. The new approach achieves accuracy comparable to simulations in which the matrix blocks are discretized, but typically requires an order of magnitude less computational time.

30735 (LBL–37200, pp. 287-292) **ITOUGH2: Solving TOUGH inverse problems.** Finsterle, S. (Lawrence Berkeley Laboratory, CA (United States)); Pruess, K. Lawrence Berkeley Lab., CA (United States). Mar 1995. DOE Contract AC03-76SF00098. (CONF-9503110–: TOUGH 95: transport of unsaturated ground water and heat workshop, Berkeley, CA (United States), 20-22 Mar 1995). In *Proceedings of the TOUGH Workshop '95 Lawrence Berkeley Laboratory, Berkeley, California, March 20–22, 1995.* 380p. Order Number DE95014788. Source: OSTI; NTIS; GPO Dep.

ITOUGH2 is a program that provides inverse modeling capabilities for the TOUGH2 code. While the main purpose of ITOUGH2 is to estimate two-phase hydraulic properties of calibrating a TOUGH2 model to laboratory or field data, the information obtained by evaluating parameter sensitivities can also be used to optimize the design of an experiment, and to analyze the uncertainty of model predictions. ITOUGH2 has been applied to a number of laboratory and field experiments on different scales. Three examples are discussed in this paper, demonstrating the code's capability to support test design, data analysis, and model predictions for a variety of TOUGH problems.

30736 (LBL–37200, pp. 305-316) **EVEGAS Project (European validation exercise of GAS migration model).** Manai, T. (Geostock S.A., Rueil-Malmaison (France)). Lawrence Berkeley Lab., CA (United States). Mar 1995. DOE Contract AC03-76SF00098. (CONF-9503110–: TOUGH 95: transport of unsaturated ground water and heat workshop, Berkeley, CA (United States), 20-22 Mar 1995). In *Proceedings of the TOUGH Workshop '95 Lawrence Berkeley Laboratory, Berkeley, California, March 20–22, 1995.* 380p. Order Number DE95014788. Source: OSTI; NTIS; GPO Dep.

The EVEGAS project aims at the verification and validation of numerical codes suitable for simulating gas flow phenomenon in low permeability porous media. Physical phenomena involved in gas generation and gas flow are numerous, often complex, and may not be very well described. The existing numerical codes cannot represent all the occurring possible phenomena, but allow a good trade-off betwen simplicity and representativity of such phenomena. Two phase flow (Gas and Water) appear to be the most consequential phenomena in gas migration and pressure sizing. The project is organised in three major steps: (1) a simple problem with analytical solutions. (2) A few problems based on laboratory or in-situ experiments. (3) A 3-D repository scenarios involving the following aspects: a repository design; a source of gas; rock characteristics; and fluid characteristics.

30737 (LBL–37477) **Transport and sorption of volatile organic compounds and water vapor in porous media.** Lin, Tsair-Fuh. Lawrence Berkeley Lab., CA (United States). Jul 1995. 195p. Sponsored by USDOE, Washington, DC (United States). DOE Contract AC03-76SF00098. Order Number DE96000112. Source: OSTI; NTIS; GPO Dep.

To gain insight on the controlling mechanisms for VOC transport in porous media, the relations among sorbent properties, sorption equilibrium and intraparticle diffusion processes were studied at the level of individual sorbent particles and laboratory columns for soil and activated carbon systems. Transport and sorption of VOCs

and water vapor were first elucidated within individual dry soil mineral grains. Soil properties, sorption capacity, and sorption rates were measured for 3 test soils; results suggest that the soil grains are porous, while the sorption isotherms are nonlinear and adsorption-desorption rates are slow and asymmetric. An intragranular pore diffusion model coupled with the nonlinear Freundlich isotherm was developed to describe the sorption kinetic curves. Transport of benzene and water vapor within peat was studied; partitioning and sorption kinetics were determined with an electrobalance. A dual diffusion model was developed. Transport of benzene in dry and moist soil columns was studied, followed by gaseous transport and sorption in activated carbon. The pore diffusion model provides good fits to sorption kinetics for VOCs to soil and VOC to granular activated carbon and activated carbon fibers. Results of this research indicate that: Intraparticle diffusion along with a nonlinea sorption isotherm are responsible for the slow, asymmetric sorption-desorption. Diffusion models are able to describe results for soil and activated carbon systems; when combined with mass transfer equations, they predict column breakthrough curves for several systems. Although the conditions are simplified, the mechanisms should provide insight on complex systems involving transport and sorption of vapors in porous media.

30738 (LBL–37554) **A field test of permeation grouting in heterogeneous soils using a new generation of barrier liquids.** Moridis, G.J. (Lawrence Berkeley Lab., CA (United States)); Persoff, P.; Apps, J.A.; Myer, L.; Pruess, K.; Yen, P. Lawrence Berkeley Lab., CA (United States). Aug 1995. 16p. Sponsored by USDOE, Washington, DC (United States). DOE Contract AC03-76SF00098. (CONF-950868–20: Environmental remediation conference: committed to results, Denver, CO (United States), 13-18 Aug 1995). Order Number DE96001123. Source: OSTI; NTIS; INIS; GPO Dep.

A field demonstration of permeation grouting was conducted at a gravel quarry near Los Banos, California, with the purpose of demonstrating the feasibility of the concept. Two grouts were used: a form of colloidal silica that gels after the addition of a gelling agent, and a polysiloxane that polymerizes after the addition of a catalyst. Both create relatively impermeable barriers in response to the large increase in viscosity during gelation or polymerization, respectively. The grouts were successfully injected at a depth between 10 and 14ft. Subsequent exhumation of the injected gravels revealed that both grouts produced relatively uniform bulbs. Laboratory measurements of the grouted material retrieved from the field showed at least a four order of magnitude reduction in permeability over the ungrouted material.

30739 (MLM-MU–89-63-0001) **Action description memorandum for the FY 1992 line item: Environmental, Safety and Health Upgrades, Phase 4, Site Drainage Control.** Adams, F.S.; Hunter, M.R. EG and G Mound Applied Technologies, Miamisburg, OH (United States). Mar 1989. 4p. Sponsored by USDOE, Washington, DC (United States). DOE Contract AC24-88DP43495. Order Number DE96000798. Source: OSTI; NTIS; GPO Dep.

This ADM documents the evaluation of the potential environmental impact hazards from the Environmental, Safety and Health Upgrades, Phase 4, Site Drainage Control Project.

30740 (MLM-MU–89-64-0012) **Environmental quality control report. [Semiannual] report, July–December 1988.** Bishop, C.T. EG and G Mound Applied Technologies, Miamisburg, OH (United States). 14 Apr 1989. 8p. Sponsored by USDOE, Washington, DC (United States). DOE Contract AC24-88DP43495. Order Number DE96000796. Source: OSTI; NTIS; GPO Dep.

This report presents the details of the Mound Laboratory EPA-NPDES Quality Assurance Program, the DOE Quality Assessment Program Results, Proficiency Environmental Testing Program and Plutonium in Urine Quality Control for 1988.

30741 (ORNL/TM–11210) **Disposal of chemical agents and munitions stored at Pueblo Depot Activity, Colorado. Final, Phase 1: Environmental report.** Terry, J.W.; Blasing, T.J.; Ensminger, J.T.; Johnson, R.O.; Schexnayder, S.M.; Shor, J.T.; Staub, W.P.; Tolbert, V.R.; Zimmerman, G.P. Oak Ridge National Lab., TN (United States). Apr 1995. 300p. Sponsored by Department of Defense, Washington, DC (United States). DOE Contract AC05-84OR21400. Order Number DE96000883. Source: OSTI; NTIS; GPO Dep.

Under the Chemical Stockpile Disposal Program (CSDP), the US Army proposes to dispose of lethal chemical agents and munitions stored at eight existing Army installations in the continental United States. In 1988, the US Army issued the final programmatic environmental impact statement (FPEIS) for the CSDP. The FPEIS and the subsequent Record of Decision (ROD) identified an on-site disposal process as the preferred method for destruction of the stockpile. That is, the FPEIS determined the environmentally preferred alternative to be on-site disposal in high-temperature incinerators, while the ROD selected this alternative for implementation as the preferred method for destruction of the stockpile. In this Phase I report, the overall CSDP decision regarding disposal of the PUDA Stockpile is subjected to further analyses, and its validity at PUDA is reviewed with newer, more detailed data than those providing the basis for the conclusions in the FPEIS. The findings of this Phase I report will be factored into the scope of a site-specific environmental impact statement to be prepared for the destruction of the PUDA stockpile. The focus of this Phase I report is on those data identified as having the potential to alter the Army's previous decision regarding disposal of the PUDA stockpile; however, several other factors beyond the scope of this Phase I report must also be acknowledged to have the potential to change or modify the Army's decisions regarding PUDA.

30742 (ORNL/TM–13032) **Environmental effects of the US Antarctic Program's use of balloons in Antarctica.** McCold, L.N.; Eddlemon, G.K.; Blasing, T.J. Oak Ridge National Lab., TN (United States). Jun 1995. 76p. Sponsored by National Science Foundation, Washington, DC (United States). DOE Contract AC05-84OR21400. Order Number DE96000853. Source: OSTI; NTIS; GPO Dep.

The USAP uses balloons in Antarctica to conduct scientific research, to facilitate safe air transport, and to provide data for global weather predictions. However, there is the possibility that balloons or their payloads may adversely affect Antarctic fauna or flora. The purpose of this study is to provide background information upon which the USAP may draw when complying with its responsibilities under the National Environmental Policy Act of 1969, the Antarctic Treaty, and the Madrid Protocol.

30743 (ORNL/TM–13051) **1995 Area 1 bird survey/Zone 1, Operable Unit 2, Robins Air Force Base, Georgia.** Wade, M.C. Oak Ridge National Lab., TN (United States). Aug 1995. 15p. Sponsored by USDOE, Washington, DC (United States). DOE Contract AC05-84OR21400. Order Number DE96000833. Source: OSTI; NTIS; GPO Dep.

Robins Air Force Base is located in Warner Robins, Georgia, approximately 90 miles southeast of Atlanta, Georgia. As part of the Baseline Investigation (CDM Federal 1994) a two day bird survey was conducted by M. C. Wade (Oak Ridge National Laboratory) and B.A. Beatty (CDM Federal Programs) in May 1995. The subject area of investigation includes the sludge lagoon, Landfill No. 4, and the wetland area east of the landfill and west of Hannah Road (including two ponds). This is known as Area 1. The Area 1 wetlands include bottomland hardwood forest, stream, and pond habitats. The objectives of this survey were to document bird species using the Area I wetlands and to see if the change in hydrology (due to the installation of the Sewage Treatment Plant effluent diversion and stormwater runon control systems) has resulted in changes at Area 1 since the previous survey of May 1992 (CDM Federal 1994).

30744 (PNC-TN–1100-94-003, pp. IV/73-IV/84) **Japanese issues on the future behavior of the geological environment.** Aoki, Kaz (Power Reactor and Nuclear Fuel Development Corp., Tokyo (Japan)); Nakatsuka, Noboru; Ishimaru, Tsuneari. Power Reactor and Nuclear Fuel Development Corp., Tokyo (Japan). 1994. (CONF-9311199–: International workshop on research and development of geological disposal, Tokai (Japan), 15-19 Nov 1993). In *Proceedings of technical session on research and development of geological disposal.* 379p. Order Number DE95757546. Source: OSTI; NTIS; INIS.

Comprehending and predicting the future states of the geological environment is very important in ensuring a safe geological disposal of high level radioactive wastes (HLW). This paper is one in a series of studies required to ascertain the existence of a geologically stable area in Japan over the long term. In particular, interest is focussed on the aspect of accumulating data on behavior patterns of selected natural phenomena which will enable predictions of future behavior of geological processes and finding of areas of long term stability. While this paper limits itself to the second and part of the third step, the overall flow-chart of study on natural processes and events which may perturb the geological environment entails three major steps. They include: (i) identification of natural processes and events relevant to long term stability of geological environment to be evaluated; (ii) characterization of the identified natural processes and events; and (iii) prediction of the probability of occurrence, magnitude and influence of the natural processes and events which may perturb the geological environment. (J.P.N).

30745 (PNL–10728) **Radionuclide concentrations in terrestrial vegetation and soil on and around the Hanford Site, 1983 through 1993.** Poston, T.M.; Antonio, E.J.; Cooper, A.T. Pacific Northwest Lab., Richland, WA (United States). Aug 1995. 80p. Sponsored by USDOE, Washington, DC (United States). DOE Contract AC06-76RL01830. Order Number DE95017597. Source: OSTI; NTIS; INIS; GPO Dep.

This report reviews concentrations of ^{60}Co, ^{90}Sr, ^{137}Cs, U isotopes, ^{238}Pu, $^{239,240}Pu$, and ^{241}Am in soil and vegetation samples collected from 1983 through 1993 during routine surveillance of the Hanford Site. Sampling locations were grouped in study areas associated with operational areas on the Site. While radionuclide concentrations were very low and representative of background concentrations from historic fallout, some study areas on the Site contained slightly elevated concentrations compared to other study areas onsite and offsite. The 100 Areas had concentrations of ^{60}Co comparable to the minimum detectable concentration of 0.02 pCi/g in soil. Concentrations of ^{90}Sr, ^{137}Cs, ^{238}Pu, $^{239,240}Pu$, and ^{241}Am in 200 Area soils were slightly elevated. The 300 Area had a slight elevation of U in soil. These observations were expected because many of the sampling locations were selected to monitor specific facilities or operations at the operational areas. Generally, concentrations of the radionuclides studied were greater and more readily measured in soil samples compared to vegetation samples. The general pattern of concentrations of radionuclide concentrations in vegetation by area mirrored that observed in soil. Declines in ^{90}Sr in soil appear to be attributed to radioactive decay and possibly downward migration out of the sampling horizon. The other radionuclides addressed in this report strongly sorb to soil and are readily retained in surface soil. Because of their long half-lives compared to the length of the study period, there was no significant indication that concentrations of U isotopes and Pu isotopes were decreasing over time.

30746 (PNL–10786) **Clean option: Berkeley Pit water treatment and resource recovery strategy.** Gerber, M.A.; Orth, R.J.; Elmore, M.R.; Monzyk, B.F. Pacific Northwest Lab., Richland, WA (United States). Sep 1995. 90p. Sponsored by USDOE, Washington, DC (United States). DOE Contract AC06-76RL01830. Order Number DE96000746. Source: OSTI; NTIS; INIS; GPO Dep.

The US Department of Energy (DOE), Office of Technology Development, established the Resource Recovery Project (RRP) in 1992 as a five-year effort to evaluate and demonstrate multiple technologies for recovering water, metals, and other industrial resources from contaminated surface and groundwater. Natural water resources located throughout the DOE complex and the and western states have been rendered unusable because of contamination from heavy metals. The Berkeley Pit, a large, inactive, open pit copper mine located in Butte, Montana, along with its associated groundwater system, has been selected by the RRP for use as a feedstock for a test bed facility located there. The test bed facility provides the infrastructure needed to evaluate promising technologies at the pilot plant scale. Data obtained from testing these technologies was used to assess their applicability for similar mine drainage water applications throughout the western states and at DOE. The objective of the Clean Option project is to develop strategies that provides a comprehensive and integrated approach to resource recovery using the Berkeley Pit water as a feedstock. The strategies not only consider the immediate problem of resource recovery from the contaminated water, but also manage the subsequent treatment of all resulting process streams. The strategies also employ the philosophy of waste minimization to optimize reduction of the waste volume requiring disposal, and the recovery and reuse of processing materials.

30747 (PNL–10817) **Hydrochemistry and hydrogeologic conditions within the Hanford Site upper basalt confined aquifer system.** Spane, F.A. Jr.; Webber, W.D. Pacific Northwest Lab., Richland, WA (United States). Sep 1995. 70p. Sponsored by USDOE, Washington, DC (United States). DOE Contract AC06-76RL01830. Order Number DE96001153. Source: OSTI; NTIS; INIS; GPO Dep.

As part of the Hanford Site Ground-Water Surveillance Project, Flow System Characterization Task. Pacific Northwest Laboratory examines the potential for offsite migration of contamination within the upper basalt confined aquifer system for the US Department of Energy (DOE). As part of this activity, groundwater samples were collected over the past 2 years from selected wells completed in the upper Saddle Mountains Basalt. The hydrochemical and isotopic information obtained from these groundwater samples provides hydrologic information concerning the aquifer-flow system. Ideally, when combined with other hydrologic property information, hydrochemical and isotopic data can be used to evaluate the origin and source of groundwater, areal groundwater-flow patterns, residence and groundwater travel time, rock/groundwater reactions, and aquifer intercommunication for the upper basalt confined aquifer system. This report presents the first comprehensive Hanford Site-wide summary of hydrochemical properties for the upper basalt confined aquifer system. This report provides the hydrogeologic characteristics (Section 2.0) and hydrochemical properties (Section 3.0) for groundwater within this system. A detailed description of the range of the identified hydrochemical parameter subgroups for groundwater in the upper basalt confined aquifer system is also presented in Section 3.0. Evidence that is indicative of aquifer contamination/aquifer intercommunication and an assessment of the potential for offsite migration of contaminants in groundwater within the upper basalt aquifer is provided in Section 4.0. The references cited throughout the report are given in Section 5.0. Tables that summarize groundwater sample analysis results for individual test interval/well sites are included in the Appendix.

30748 (PNL–10834) **Mapping of top of permafrost using a direct current resistivity survey.** Gilmore, T.J.; Clayton, E.A. Pacific Northwest Lab., Richland, WA (United States). Oct 1995. 48p. Sponsored by USDOE, Washington, DC (United States). DOE Contract AC06-76RL01830. Order Number DE96001419. Source: OSTI; NTIS; GPO Dep.

Data from a direct current resistivity survey and geologic logs from boreholes were used to map the top of permafrost at a remote Air Force installation in Alaska. This study resulted from a remedial investigation that was conducted at Eielson Air Force base near Fairbanks, Alaska under the federal Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA) regulations. The depth and continuity of the permafrost was important in determining the fate of petroleum contamination that was inadvertently discharged to the ground during earlier Air Force operations. The results indicate that the top of permafrost forms a highly irregular surface. In general, however, the top of permafrost forms a diagonal ridge at the center of the contour grid that is bordered on each side by troughs.

30749 (SAND–95-1247) **Mathematical and numerical formulation of nonisothermal multicomponent three-phase flow in porous media.** Martinez, M.J. Sandia National Labs., Albuquerque, NM (United States). Sep 1995. 27p. Sponsored by USDOE, Washington, DC (United States). DOE Contract AC04-94AL85000. Order Number DE95017639. Source: OSTI; NTIS; GPO Dep.

A mathematical formulation is presented for describing the transport of air, water, NAPL, and energy through porous media. The development follows a continuum mechanics approach. The theory assumes the existence of various average macroscopic variables which describe the state of the system. Balance equations for mass and energy are formulated in terms of these macroscopic

variables. The system is supplemented with constitutive equations relating fluxes to the state variables, and with transport property specifications. Specification of phase equilibrium criteria, various mixing rules and thermodynamic relations completes the system of equations. A numerical simulation scheme based on finite-differences is described.

30750 (UCRL-ID–114369) **Removing hexavalent chromium from subsurface waters with anion-exchange resin.** Torres, R.A. Lawrence Livermore National Lab., CA (United States). Jun 1995. 26p. Sponsored by USDOE, Washington, DC (United States). DOE Contract W-7405-ENG-48. Order Number DE96000101. Source: OSTI; NTIS; GPO Dep.

Some subsurface waters at Lawrence Livermore National Laboratory (LLNL) are contaminated with volatile organic compounds (VOCs). Hexavalent chromium, Cr(VI), is also present in the ground water; however, the source of the Cr(VI) may be natural. The Cr(VI) still must be treated if brought to the surface because its concentration exceeds discharge standards. We are planning facilities for removing the VOCs and Cr(VI) to a level below the discharge standards. The planned treatment includes the following steps: (1) Pumping the water to the surface facility. (2) Purging the VOCs with air and absorbing them on activated carbon. The VOCs in LLNL's subsurface waters are primarily chlorinated organic solvents, such as dichloroethylene (DCE), trichloroethylene (TCE), perchloroethylene (PCE), and chloroform ($CHCl_3$). Contamination levels range from tens to thousands of parts per billion. (3) Filtering the water. (4) Passing the water through anion-exchange resin to remove the Cr. The Cr in LLNL subsurface waters occurs almost entirely as Cr(VI), which exists as the chromate anion, CrO_4^{2-}, at environmental pH. Cr levels range from tens to hundreds of parts per billion. (5) Discharging the treated water into the local arroyos. The relevant discharge criteria are 5 ppb total VOCs, 11 ppb Cr(VI), and pH between 6.5 and 8.5, inclusive. This report describes laboratory experiments undertaken to learn how the proposed treatment facility can be expected to operate. The laboratory results are expected to supply vendors with the detailed performance specifications needed to prepare bids on the Cr removal portion of the treatment facility. The treatment facility is expected to process 60 gallons per minute (gpm) of water by stripping VOCs with 720 standard cubic feet per minute (scfm) of air and removing Cr(VI) with 60 ft^3 of resin.

30751 (UCRL-ID–114972-2, pp. 10, Paper 13) **Isotope labeled immunoassay for environmental chemical detection.** Velez, M.M. (Lawrence Livermore National Laboratory, CA (United States)). Lawrence Livermore National Lab., CA (United States). 6 May 1994. (CONF-9405328–Absts.: Science and Engineering Research Semester (SERS) student symposium, Livermore, CA (United States), 6 May 1994). In *SERS intership: Spring 1994 abstracts and research papers*. 195p. Order Number DE95014118. Source: OSTI; NTIS: GPO Dep.

Altrazine, one of the most heavily used agricultural pesticides in North America, has been identified as a major groundwater contaminant in the U.S. Research provides evidence that under certain conditions atrazine and some of its derivatives may prove to be carcinogenic and mutagenic. Immunossays are one of the most powerful of all analytical immunochemical techniques. They employ a wide range of methods to detect and quantitate antigens or antibodies, and to study the structure of antigens. With the appropriate assay, they can be remarkably quick and easy, to yield information that would be difficult to determine by other techniques. The development of the appropriate assay; however, requires clean and precise separation of antigens bound to antibodies from those that remain free. Sensitive assays depend on quantification of these bound antigens at very low levels. We are making direct and competitive immunoassays with atrazine and its antibodies using accelerator mass spectrometry (AMS) in order to obtain a sensitive immunoassay for atrazine in environmental samples.

30752 (UCRL-ID–114972-2, pp. 14, Paper 8) **Chromium removal from ground water by ion exchange resins.** Skiadas, P. Lawrence Livermore National Lab., CA (United States). 6 May 1994. (CONF-9405328–Absts.: Science and Engineering Research Semester (SERS) student symposium, Livermore, CA (United States), 6 May 1994). In *SERS intership: Spring 1994 abstracts and research papers*. 195p. Order Number DE95014118. Source: OSTI; NTIS; GPO Dep.

The ground water at several monitoring wells at LLNL has been found to exceed the Surface Water Discharge Limits for Cr(VI). Ion exchange resins have been selected for its removal. A research study is underway to determine which commercial resin is preferred for LLNL's ground water. The choice of an appropriate resin will be based on Cr(VI) exchange capacity, regeneration efficiency, and pH stabilization. A sequestering agent must also be selected to be used for the elimination of scaling at the treatment facilities. The chemistry of ion exchange resins, and instrumentation and procedures are explained and described in the following paper. Comparison of the different resins tested lead us to the selection of the most effective one to be used in the treatment facilities.

30753 (UCRL-ID–119210) **Genesis Eco Systems, Inc. soil washing process.** Cena, R.J. Lawrence Livermore National Lab., CA (United States). 11 Oct 1994. 13p. Sponsored by USDOE, Washington, DC (United States). DOE Contract W-7405-ENG-48. Order Number DE95017056. Source: OSTI; NTIS; INIS; GPO Dep.

The Genesis soil washing system is an integrated system of modular design allowing for maximum material handling capabilities, with optimized use of space for site mobility. The Surfactant Activated Bio-enhanced Remediation Equipment-Generation 1 (SABRE-1, Patent Applied For) modification was developed specifically for removing petroleum byproducts from contaminated soils. Scientifically formulated surfactants, introduced by high pressure spray nozzles, displace the contaminant from the surface of the soil particles into the process solution. Once the contaminant is dispersed into the liquid fraction of the process, it is either mechanically removed, chemically oxidized, or biologically oxidized. The contaminated process water is pumped through the Genesis Biosep (Patent Applied For) filtration system where the fines portion is flocculated, and the contaminant-rich liquid portion is combined with an activated mixture of nutrients and carefully selected bacteria to decompose the hydrocarbon fraction. The treated soil and dewatered fines are transferred to a bermed stockpile where bioremediation continues during drying. The process water is reclaimed, filtered, and recycled within the system.

30754 (UCRL-ID–119656) **Compilation of the Dakota Aquifer Project isotope data and publications: The Isotope Hydrology Program of the Isotope Sciences Division.** Davisson, M.L. (Lawrence Livermore National Lab., CA (United States)); Smith, D.K.; Hudson, G.B.; Niemeyer, S.; Macfarlane, P.A.; Whittemore, D.O. Lawrence Livermore National Lab., CA (United States). Jan 1995. 14p. Sponsored by USDOE, Washington, DC (United States). DOE Contract W-7405-ENG-48. Order Number DE95017057. Source: OSTI; INIS; NTIS; GPO Dep.

In FY92 the then Nuclear Chemistry Division embarked on a scientific collaboration with the Kansas Geological Survey (KGS) to characterize with isotope techniques groundwater of the Dakota Formation of Kansas. The Dakota Formation is a Cretaceous-aged marine sandstone hosting potable groundwater in most regions of Kansas whose use will serve to partially offset the severe overdraft problems in the overlying Ogallala Formation. The isotope characterization of the Dakota groundwater has generated data that delineates sources, ages, and subsurface controls on the water quality. Initial interpretations of the data have been published in abstract volumes of (1) the 1993 Geological Society of America National Meeting, (2) the 8th International Conference on Geochronology, Cosmochronology and Isotope Geology, and (3) the 1994 Dakota Aquifer Workshop and Clinic. Copies of all abstracts are included in this brief review. One report will focus on the sources and ages of the groundwater, and the other will focus on the subsurface controls on the natural water quality.

30755 (UCRL-ID–119759) **Livermore Big Trees Park Soil Survey.** McConachie, W.A.; Failor, R.A. Lawrence Livermore National Lab., CA (United States). Jan 1995. 10p. Sponsored by USDOE, Washington, DC (United States). DOE Contract W-7405-ENG-48. Order Number DE96000333. Source: OSTI; NTIS; INIS; GPO Dep.

Lawrence Livermore National Laboratory (LLNL) will sample and analyze soil in the Big Trees Park area in Livermore, California, to determine if the initial level of plutonium (Pu) in a soil sample taken

by the U.S. Environmental Protection Agency (EPA) in September 1993 can be confirmed. Nineteen samples will be collected and analyzed: 4 in the area where the initial EPA sample was taken, 2 in the nearby Arroyo Seco, 12 in scattered uncovered soil areas in the park and nearby school, and 1 from the sandbox of a nearby apartment complex. Two quality control (QC) samples (field duplicates of the preceding samples) win also be collected and analyzed. This document briefly describes the purpose behind the sampling, the sampling rationale, and the methodology.

30756 (UCRL-JC–116594) **Seasonal and intraspecific variability of chlorophyll fluorescence, pigmentation and growth of Pinus ponderosa subjected to elevated CO_2.** Houpis, J.L.J. (Lawrence Livermore National Lab., CA (United States)); Anschel, D.; Pushnik, J.C.; Demaree, R.S.; Anderson, P.D. Lawrence Livermore National Lab., CA (United States). Dec 1994. 20p. Sponsored by USDOE, Washington, DC (United States). DOE Contract W-7405-ENG-48. (CONF-9409301–3: 16. international meeting for specialists in air pollution effects on forest ecosystems, air pollution and multiple stresses, New Brunswick (Canada), 7-9 Sep 1994). Order Number DE95017856. Source: OSTI; NTIS; GPO Dep.

Atmospheric $CO_2$2 is expected to double in the next century, and these increases will have substantial impact on forest ecosystems. However, the database on the effects of elevated CO_2 on forests is limited, and the extent of intraspecific variability remains unknown. We are investigating the effects of elevated CO_2 on the intraspecific variability of quantum yield (as measured through chlorophyll fluorescence Fv/Fm ratio) and pigmentation, and how these are correlated to variability in growth. Four-year-old Pinus ponderosa seedlings were obtained from nine different sources across California. These seedlings were grown in standard outdoor exposure chambers for sixteen months at either ambient levels of CO_2, ambient+175ppm CO_2, or ambient+350ppm CO_2. The seedlings were periodically measured for growth, pigmentation, and chlorophyll fluorescence. The results showed a variable growth response of the nine sources during all measurement periods. Increasing CO_2 resulted in a decrease in Fv/Fm among sources ranging from −2.1% to −23.2% in February, and 3.1% to −12.5% in June. The source that had the best growth throughout the study, also had a minimal reduction in quantum yield (Fv/Fm) in the presence of elevated CO_2. For the seedlings of fastest growing sources, the correspondence between total growth and chlorophyll fluorescence was strongest during the February measurement period. Our results also showed a significant reduction in pigmentation due to increased CO_2. There are at least three explanations for the different responses during each measurement periods. First, the trees could be adapting favorably to increasing CO_2. Secondly, 1993 needles could be under less physiological stress than the current year needles. Third, there is a seasonal effect dependent upon temperature or light which is influencing the Fv/Fm ratio and pigmentation.

30757 (UCRL-JC–118024) **Laboratory treatability studies preparatory to field testing a resting-cell in situ microbial filter bioremediation strategy.** Taylor, R.T.; Hanna, M.L. Lawrence Livermore National Lab., CA (United States). Apr 1995. 14p. Sponsored by USDOE, Washington, DC (United States);National Aeronautics and Space Administration, Washington, DC (United States). DOE Contract W-7405-ENG-48. (CONF-950483–7: 3. international symposium on in situ and on-site bioreclamation, San Diego, CA (United States), 24-27 Apr 1995). Order Number DE96000360. Source: OSTI; NTIS; INIS; GPO Dep.

Prior to a down-hole-column treatability test of a Methylosinus trichosporium OB3b attached-resting-cell in situ biofilter strategy, a set of three sequential laboratory experiments were carried out to define several key operational parameters and to evaluate the likely degree of success at a NASA Kennedy Space Center site. They involved the cell attachment to site-specific sediments, the intrinsic resting-cell biotransformation capacities for the contaminants of interest plus their time-dependent extents of biodegradative removal at the concentrations of concern, and a scaled in situ mini-flow-through-column system that closely mimics the subsurface conditions during a field-treatability or pilot test of an emplaced resting-cell filter. These experiments established the conditions required for the complete metabolic removal of a vinyl chloride (VC), cis-dichlororthylene (cis-DCE) and trichloroethylene (TCE) mixture. However, the gas chromatographic (GC) procedures that we utilized and the mini-flow-through column data demonstrated that, at most, only about 50–70% of the site-water VC, cis-DCE, and TCE would be biodegraded. This occurred because of a limiting level of dissolved oxygen, which was exacerbated by the simultaneous presence of several additional previously unrecognized groundwater components, especially methane, that are also competing substrates for the whole-cell soluble methane monooxygenase (sMMO) enzyme complex. Irrespective, collectively the simplicity of the methods that we have developed and the results obtainable with them appear to provide relevant laboratory-based test-criteria before taking our microbial filter strategy to an in situ field treatability or pilot demonstration stage at other sites in the future.

30758 (UCRL-JC–119863) **Remote measurement of ground source emissivity.** Henderson, J.R. Lawrence Livermore National Lab., CA (United States). Jul 1995. 11p. Sponsored by USDOE, Washington, DC (United States). DOE Contract W-7405-ENG-48. (CONF-950778–2: ACM conference on computational learning theory, Santa Cruz, CA (United States), Jul 1995). Order Number DE95015375. Source: OSTI; NTIS; GPO Dep.

The remote measurement of the emissivity of ground materials is of tremendous value in their identification and mapping. Traditional techniques use reflected solar radiation for this measurement for wavelengths shorter than 5 μm. With the development of new techniques, the 10 Jim atmospheric transmission window might also be used for this purpose. Previous work using the multi-angle data acquisition technique demonstrated its utility to determine source thermal emission. Here we find the multi-angle technique can be used to determine the source specular reflectivity to ~0.05 if there is very good system performance (NETD $\approx$ 0.01 K).

30759 (UCRL-JC–120613) **A new breed of innovative ground water modeling.** Gelinas, R.J. (Lawrence Livermore National Lab., CA (United States)); Doss, S.K.; Ziagos, J.; McKereghan, P.; Vogele, T.; Nelson, R.G. Lawrence Livermore National Lab., CA (United States). Jul 1995. 10p. Sponsored by USDOE, Washington, DC (United States). DOE Contract W-7405-ENG-48. (CONF-950868–19: Environmental remediation conference: committed to results, Denver, CO (United States), 13-18 Aug 1995). Order Number DE96000394. Source: OSTI; NTIS; INIS; GPO Dep.

Sparse data is a critical obstacle in every ground water remediation project. Lack of data necessitates non-unique interpolations that can distort modeled distributions of contaminants and essential physical properties (e.g., permeability, porosity). These properties largely determine the rates and paths that contaminants may take in migrating from sources to receptor locations. We apply both forward and inverse model estimates to resolve this problem because coupled modeling provides the only way to obtain constitutive property distributions that simultaneously simulate the flow and transport behavior observed in borehole measurements. Innovations in multidimensional modeling are a key to achieving more effective subsurface characterizations, remedial designs, risk assessments, and compliance monitoring in efforts to accelerate cleanup and reduce costs in national environmental remediations. Fundamentally new modeling concepts and novel software have emerged recently from two decades of research on self-adaptive solvers of partial differential equations (PDEs). We have tested a revolutionary software product, PDEase, applying it to coupled forward and inverse flow problems. In the Superfund cleanup effort at Lawrence Livermore National Laboratory's (LLNL) Livermore Site, the new modeling paradigm of PDEase enables ground water professionals to simply provide the flow equations, site geometry, sources, sinks, constitutive parameters, and boundary conditions. Its symbolic processors then construct the actual numerical solution code and solve it automatically. Powerful grid refinements that conform adaptively to evolving flow features are executed dynamically with iterative finite-element solutions that minimize numerical errors to user-specified limits. Numerical solution accuracy can be tested easily with the diagnostic information and interactive graphical displays that appear as the solutions are generated.

30760 (UCRL-JC–121019) **An Automated Land Analysis System (ALAS) for applications at a range of spatial scales: Watershed to global.** Miller, N.L. Lawrence Livermore National Lab., CA (United States). Aug 1995. 6p. Sponsored by USDOE,

Washington, DC (United States). DOE Contract W-7405-ENG-48. (CONF-9508170–1: EPA workshop on next generation environmental models computational methods, Bay City, MI (United States), 7-9 Aug 1995). Order Number DE96000362. Source: OSTI; NTIS; GPO Dep.

Recent advances in Digital Elevation Model (DEM) data availability and topographic analysis have enabled us to develop an Automated Land Analysis System (ALAS). ALAS is based on a series of codes which determine topographic and hydrologic characteristics at each pixel, watershed, and each large scale cell. The input requirements are a DEM from any location in the world, it's resolution, and array size. A Motif accessed script reads in these inputs and generates a series of data sets which further describe the watershed properties such as flow directions, hydrologic characteristic probability density functions, etc.). Postscript files and arrays indicating the fme river networks and each subcatchment, as well as numerous other properties, are produced and catalogued. The motivation behind the development of ALAS is a direct response to the conceptualization of convergent scales between hydrologic and atmospheric models as defined by the World Climate Research Programme. The remainder of this paper highlights ALAS components, capabilities, and provides some discussion on its applications.

30761 (USGS-OFR–95-160) **Ground-water data for the Nevada Test Site and selected other areas in South-Central Nevada, 1992–1993.** Geological Survey, Denver, CO (United States). 1995. 50p. Sponsored by Department of the Interior, Washington, DC (United States);USDOE, Washington, DC (United States). DOE Contract AI08-86NV10583. Order Number DE96000244. Source: OSTI; NTIS; INIS; U.S. Geological Survey, Information Services, Box 25286, MS 517, Denver Federal Center, Denver, CO (United States) 80225-0046; GPO Dep.

The US Geological Survey, in support of the US Department of Energy Environmental Restoration and Hydrologic Resources Management Programs, collects and compiles hydrogeologic data to aid in characterizing the regional and local ground-water flow systems underlying the Nevada Test Site and vicinity. This report presents selected ground-water data collected from wells and test holes at and in the vicinity of the Nevada Test Site. Depth-to-water measurements were made during water year 1993 at 55 sites at the Nevada Test Site and 43 regional sites in the vicinity of the Nevada Test Site. Depth to water ranged from 87.7 to 674.6 meters below land surface at the Nevada Test Site and from 6.0 to 444.7 meters below land surface at sites in the vicinity of the Nevada Test Site. Depth-to-water measurements were obtained using the wire-line, electric-tape, air-line, and steel-tape devices. Total measured ground-water withdrawal from the Nevada Test Site during the 1993 calendar year was 1,888.04 million liters. Annual ground-water withdrawals from 14 wells ranged from 0.80 million to 417.20 million liters. Tritium concentrations from four samples at the Nevada Test Site and from three samples in the vicinity of the Nevada Test Site collected during water year 1993 ranged from near 0 to 27,676.0 becquerels per liter and from near 0 to 3.9 becquerels per liter, respectively.

30762 (USGS-OFR–95-284) **Ground-water data for the Nevada Test Site 1992, and for selected other areas in South-Central Nevada, 1952–1992.** Geological Survey, Denver, CO (United States). [1992]. 60p. Sponsored by Department of the Interior, Washington, DC (United States);USDOE, Washington, DC (United States). DOE Contract AI08-86NV10583. Order Number DE96000243. Source: OSTI; NTIS; INIS; U.S. Geological Survey, Information Services, Box 25286, MS 517, Denver Federal Center, Denver, CO (United States) 80225-0046; GPO Dep.

Ground-water data collected from wells and test holes at and in the vicinity of the Nevada Test Site have been compiled in a recently released report. These data were collected by the US Geological Survey, Department of the Interior, in support of the US Department of Energy, Environmental Restoration and Hydrologic Resources Management Programs. Depth-to-water measurements were made at 53 sites at the Nevada Test Site from October 1, 1991, to September 30, 1992, and at 60 sites in the vicinity of the Nevada Test Site from 1952 to September 30, 1992. For water year 1992, depth to water ranged from 288 to 2,213 feet below land surface at the Nevada Test Site and from 22 to 1,460 feet below land surface at sites in the vicinity of the Nevada Test Site. Total groundwater withdrawal data compiled for 12 wells at the Nevada Test Site during calendar year 1992 was more than 400 million gallons. Tritium concentrations in water samples collected from five test holes at the Nevada Test Site in water year 1992 did not exceed the US Environmental Protection Agency drinking, water limit.

30763 (WHC-SA–2925-FP) **Evaluation of chromium speciation and transport characteristics in the Hanford Site 100D and 100H areas.** Thornton, E.C. (and others); Amonette, J.E.; Olivier, J. Westinghouse Hanford Co., Richland, WA (United States). Aug 1995. 21p. Sponsored by USDOE, Washington, DC (United States). DOE Contract AC06-87RL10930. (CONF-9508172–1: 1. symposium on the hydrogeology of Washington state, Olympia, WA (United States), 28-30 Aug 1995). Order Number DE96001102. Source: OSTI; NTIS; INIS; GPO Dep.

Field and laboratory investigations have been conducted to define the fate and transport characteristics of chromium contamination present in the 100D/H Areas of the Hanford Site. This information is relevant to assessing the impact of the release of hexavalent chromium to the Columbia River. Included in this study was the determination of the concentration and aqueous speciation of chromium in the unconfined acquifer and an assessment of potential changes in speciation as groundwater passes through the river/acquifer transition zone and mixes with the Columbia River. The results of this study indicate that chromium present within the Hanford acquifer is predominantly in the oxidized hexavalent state. Chromium is apparently stable in the oxidized form owing to its lack of organic matter within the acquifer. A portion of the chromium is removed as groundwater passes through the transition zone due to reduction and precipitation associated with sediment/water interaction processes. Chemical data collected from seep water samples, however, suggests, that most of the hexavalent chromium ultimately discharges into the Columbia River. Dilution of hexavalent chromium subsequently occurs during the mixing of groundwater and river water, with relatively little change taking place in speciation.

30764 (WHC-SP–0665-17) **Quarterly environmental radiological survey summary: Second Quarter 1995 100, 200, 300, and 600 Areas.** McKinney, S.M. Westinghouse Hanford Co., Richland, WA (United States). 27 Jul 1995. 22p. Sponsored by USDOE, Washington, DC (United States). DOE Contract AC06-87RL10930. Order Number DE96001070. Source: OSTI; NTIS; INIS; GPO Dep.

This report provides a summary of the radiological surveys performed in support of the operational environmental monitoring program at the Hanford Site. The Second Quarter 1995 survey results and the status of actions required from current and past reports are summarized.

30765 (WSRC-RP–95-89) **Verification of VENTSAR.** Simpkins, A.A. Westinghouse Savannah River Co., Aiken, SC (United States). Jan 1995. 39p. Sponsored by USDOE, Washington, DC (United States). DOE Contract AC09-89SR18035. Order Number DE95017488. Source: OSTI; NTIS; GPO Dep.

The VENTSAR code is an upgraded and improved version of the VENTX code, which estimates concentrations on or near a building from a release at a nearby location. The code calculates the concentrations either for a given meteorological exceedance probability or for a given stability and wind speed combination. A single building can be modeled which lies in the path of the plume, or a penthouse can be added to the top of the building. Plume rise may also be considered. Release types can be either chemical or radioactive. Downwind concentrations are determined at user-specified incremental distances. This verification report was prepared to demonstrate that VENTSAR is properly executing all algorithms and transferring data. Hand calculations were also performed to ensure proper application of methodologies.

30766 (WSRC-TR–94-0609) **Sanitary landfill groundwater monitoring report. Fourth quarter 1994 and 1994 summary.** Westinghouse Savannah River Co., Aiken, SC (United States). Feb 1995. 300p. Sponsored by USDOE, Washington, DC (United States). DOE Contract AC09-89SR18035. Order Number DE95017468. Source: OSTI; NTIS; INIS; GPO Dep.

Eighty-nine wells of the LFW series monitor groundwater quality in the Steed Pond Aquifer (Water Table) beneath the Sanitary Landfill at the Savannah River Site (SRS). These wells are sampled quarterly to comply with the South Carolina Department of Health and Environmental Control Domestic Waste Permit DWP-087A and as part of the SRS Groundwater Monitoring Program. Dichloromethane, a common laboratory contaminant, and trichloroethylene were the most widespread constituents exceeding standards during 1994. Benzene, chloroethene (vinyl chloride), 1,2-dichloroethane, 1,1-dichloroethylene, 1,2-dichloropropane, gross alpha, mercury, nonvolatile beta, tetrachloroethylene, and tritium also exceeded standards in one or more wells. The groundwater flow direction in the Steed Pond Aquifer (Water Table) beneath the Sanitary Landfill was to the southeast (universal transverse Mercator coordinates). The flow rate in this unit was approximately 140 ft/year during first and fourth quarters 1994.

30767 (WSRC-TR–95-0050) **Rapid assessment of soil and groundwater tritium by vegetation sampling.** Murphy, C.E. Jr. Westinghouse Savannah River Co., Aiken, SC (United States). [1995]. 11p. Sponsored by USDOE, Washington, DC (United States). DOE Contract AC09-89SR18035. Order Number DE95017487. Source: OSTI; NTIS; INIS; GPO Dep.

A rapid and relatively inexpensive technique for defining the extent of groundwater contamination by tritium has been investigated. The technique uses existing vegetation to sample the groundwater. Water taken up by deep rooted trees is collected by enclosing tree branches in clear plastic bags. Water evaporated from the leaves condenses on the inner surface of the bag. The water is removed from the bag with a syringe. The bags can be sampled many times. Tritium in the water is detected by liquid scintillation counting. The water collected in the bags has no color and counts as well as distilled water reference samples. The technique was used in an area of known tritium contamination and proved to be useful in defining the extent of tritium contamination.

30768 (WSRC-TR–95-0145-2) **H-Area, K-Area, and Par Pond Sewage Sludge Application Sites Groundwater Monitoring Report. Second quarter 1995.** Chase, J.A. Westinghouse Savannah River Co., Aiken, SC (United States). Sep 1995. 50p. Sponsored by USDOE, Washington, DC (United States). DOE Contract AC09-89SR18035. Order Number DE96060005. Source: OSTI; NTIS; GPO Dep.

During second quarter 1995, samples from monitoring wells at the K-Area Sewage Sludge Application Site (KSS wells) and Par Pond Sewage Sludge Application Site (PSS wells) were analyzed for constituents required by SCDHEC Construction Permit 13,173. H-Area Sewage Sludge Application Site (HSS wells) samples were analyzed for constituents required by SCDHEC Construction Permit 12,076. All samples are also analyzed as requested for other constituents as part of the Savannah River Site (SRS) Groundwater Monitoring Program. Annual analyses for other constituents, primarily metals, also are required by the permits. There were no constituents which exceeded the SCDHEC final Primary Drinking Water Standard in any well from the H-Area, K-Area, and Par Pond Sewage Sludge Application Sites. There were also no constituents which were above the SRS Flag 2 criteria in any well at the three sites during second quarter 1995.

30769 (WSRC-TR–95-0276) **Land Use Baseline Report Savannah River Site.** Noah, J.C. Westinghouse Savannah River Co., Aiken, SC (United States). 29 Jun 1995. 96p. Sponsored by USDOE, Washington, DC (United States). DOE Contract AC09-89SR18035. Order Number DE96060002. Source: OSTI; NTIS; INIS; GPO Dep.

This document is to serve as a resource for Savannah River Site managers, planners, and SRS stakeholders by providing a general description of the site and land-use factors important to future use decisions and plans. The intent of this document is to be comprehensive in its review of SRS and the surrounding area.

30770 (WSRC-TR–0137-2) **Sanitary Landfill Groundwater Monitoring Report. Second Quarter 1995.** Chase, J.A. Westinghouse Savannah River Co., Aiken, SC (United States). Aug 1995. 325p. Sponsored by USDOE, Washington, DC (United States). DOE Contract AC09-89SR18035. Order Number DE96060004. Source: OSTI; NTIS; GPO Dep.

This report contains analytical data for samples taken during second quarter 1995 from wells of the LFW series located at the Sanitary Landfill at the Savannah River Site (SRS). The data are submitted in reference to the Sanitary landfill Operating Permit (DWP-087A). The report presents monitoring results that equaled or exceeded the Safe Drinking Water Act final Primary Water Standards (PDWS) or screening levels, established by the US Environmental Protection Agency (Appendix A), the South Carolina final Primary Drinking Water Standard for lead (Appendix A), or the SRS flagging criteria (Appendix B).

30771 (Y/TS–1375) **Best Management Practices (BMP) plan for potable water discharges Y-12 Plant.** Wiest, M.C. Jr. Oak Ridge Y-12 Plant, TN (United States). Jul 1995. 15p. Sponsored by USDOE, Washington, DC (United States). DOE Contract AC05-84OS21400. Order Number DE96000401. Source: OSTI; NTIS; GPO Dep.

This plan provides guidance to minimize the environmental effects from discharges of chlorinated waters, including: Flushing of potable water lines; Releases from fire hydrants during testing and maintenance of fire protection systems; Releases from sprinkler systems for maintenance or testing purposes; and Other significant releases of chlorinated water. This BMP plan is intended to meet the Y-12 Plant National Pollutant Discharge Elimination System (NPDES) permit condition, requiring that BWs be used for flushing potable water lines and similar activities. Close adherence to the steps provided in this plan will help prevent the discharge of chlorinated waters "in concentrations sufficient to be hazardous or otherwise detrimental to humans, livestock, wildlife, plant life, or fish and aquatic life in the receiving stream".

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Refer also to citation(s) 28649, 28805, 28908, 28914, 28915, 28963, 29015, 29016, 29035, 29053, 29346, 29443, 29933, 29935, 29939, 29940, 29943, 30228, 30625, 30642, 30650, 30652, 30668, 30694, 30711, 30771, 30904, 31209

30772 (BNL–62026) **Carbon dioxide, hydrographic, and chemical data obtained during the R/V Meteor cruise 15/3 in the South Atlantic Ocean. WOCE Section A9, February–March 1991.** Johnson, K.M. (Brookhaven National Lab., Upton, NY (United States)); Wallace, D.W.R.; Wilke, R.J.; Goyet, C.; Kozyr, A. Brookhaven National Lab., Upton, NY (United States); Oak Ridge National Lab., TN (United States). Jun 1995. 44p. Sponsored by USDOE, Washington, DC (United States). DOE Contract AC02-76CH00016 ; AC05-84OR21400. (ORNL/CDIAC–82; NDP–051). Order Number DE95016492. Source: OSTI; NTIS; GPO Dep.

Environmental Sciences Division Publication No. 4416.

The increase in atmospheric carbon dioxide (CO_2) concentrations (as well as in other radiatively active trace gases) because of human activity has produced serious concern regarding the heat balance of the global atmosphere (Moore and Braswell 1994). The increasing concentrations of these gases may intensify the earth's natural greenhouse effect, and force the global climate system in ways that are not well understood. The oceans play a major role in global carbon cycle processes. Carbon in the oceans is unevenly distributed because of complex circulation patterns and biogeochemical cycles, neither of which are completely understood. To better understand the ocean's role in climate and climatic changes, several large experiments have been conducted in the past, and others are currently under way. The World Ocean Circulation Experiment (WOCE) is a major component of the World Climate Research Program. Although total carbon dioxide ($TC0_2$) is not an official WOCE measurement, a coordinated effort, supported in the United States by the US Department of Energy (DOE), is being made on WOCE cruises (through 1998) to measure the global, spatial, and temporal distributions of $TC0_2$ and other carbon-related parameters. The CO_2 survey goals include estimation of the meridional transport of inorganic carbon in a manner analogous to the oceanic heat transport (Bryden and Hall 1980; Brewer et al. 1989; Roemmich and Wunsch 1985), evaluation of the exchange of CO_2 between the atmosphere and the ocean, and preparation of

a database suitable for carbon-cycle modeling and the subsequent assessment of the anthropogenic $C0_2$ increase in the oceans. The $C0_2$ survey is taking advantage of the sampling opportunities provided by the WOCE cruises during this period. The final data set is expected to cover $\gtrsim$23,000 stations.

30773 (KRC–92C-01) **A Study on The High Pure Water Production using RO.** Lee, T.W. (Korea Electric Power Corp. (KEPCO), Taejon (Korea, Republic of). Research Center); Park, K.K.; Moon, J.S.; Lee, J.B. Korea Electric Power Corp. (KEPCO), Taejon (Korea, Republic of). Research Center. 1994. 368p. (In Korean). Order Number DE96703572. Source: OSTI; NTIS (US Sales Only).

It is true that the lack of water resources is being worse due to water pollution with accelerated industrialization since 70's, regional unbalanced distribution of water resources, and the fluctuation of rainfall caused by the climate change. The purpose of this study lies in developing a process which can produce high purity water by applying RO ahead of the ion exchange(IX) tower and evaluating the product water quality and the cost effectiveness in order to secure water source for power plant. As a result, RO+IX system to produce high quality water was developed. It was revealed that raw water TDS of 200ppm was the even point of capital cost in the case of counter flow regeneration and TDS of 110ppm in the case of cocurrent flow regeneration when RO system was installed ahead of existing IX and TDS of 80ppm in total solids for new plant RO+MBP process. (author). 10 refs., figs.

30774 (LA–12926-PR) **Water supply at Los Alamos during 1992.** Purtymun, W.D.; McLin, S.G.; Stoker, A.K.; Maes, M.N. Los Alamos National Lab., NM (United States). Sep 1995. 59p. Sponsored by USDOE, Washington, DC (United States). DOE Contract W-7405-ENG-36. Order Number DE95017248. Source: OSTI; NTIS; GPO Dep.

Municipal potable water supply during 1992 was $1,516 \times 10^6$ gallons from wells in the Guaje and Pajarito well fields. About 13×10^6 gallons were pumped from the Los Alamos Well Field and used in the construction of State Road 501 adjacent to the Field. The last year the Las Alamos Field was used for municipal supply was 1991. The nonpotable water supply used for steam plant support was about 0.12×10^6 gallons from the spring gallery in Water Canyon. No nonpotable water was used for irrigation from Guaje and Los Alamos Reservoirs. Thus, the total water usage in 1992 was about $1,529 \times 10^6$ gallons. Neither of the two new wells in the Otowi Well Field were operational in 1992.

30775 (ORNL/CDIAC–84) **Total carbon dioxide, hydrographic, and nitrate measurements in the Southwest Pacific during Austral autumn, 1990: Results from NOAA/PMEL CGC-90 cruise.** Lamb, M.F. (Pacific Marine Environmental Lab., Seattle, WA (United States)); Feely, R.A.; Moore, L. Oak Ridge National Lab., TN (United States). Carbon Dioxide Information Analysis Center. [1995]. 80p. Sponsored by USDOE, Washington, DC (United States). DOE Contract AC05-84OR21400. Order Number DE96001357. Source: OSTI; NTIS; GPO Dep.

In support of the National Oceanic and Atmospheric Administration (NOAA) Climate and Global Change (C&GC) Program, Pacific Marine Environmental Laboratory (PMEL) scientists have been measuring the growing burden of greenhouse gases in the thermocline waters of the Pacific Ocean since 1980. Collection of data at a series of hydrographic stations along longitude 170° W during austral autumn of 1990 was designed to enhance understanding of the increase in the column burden of chlorofluorocarbons and carbon dioxide in the thermocline waters since the last expedition in 1984. This document presents the procedures and methods used to obtain total carbon dioxide (TCO_2), hydrographic, and nitrate data during the NOAA/PMEL research vessel (R/V) Malcolm Baldrige CGC-90 Cruise. Data were collected along two legs; sampling for Leg 1 began along 170° W from 15° S to 60° S, then angled northwest toward New Zealand across the Western Boundary Current. Leg 2 included a reoccupation of some stations between 30° S and 15° S on 170° W and measurements from 15° S to 5° N along 170° W. The following data report summarizes the TCO_2, salinity, temperature, and nitrate measurements from 63 stations. The TCO, concentration in seawater samples was measured using a coulometric/extraction system (Models 5011 and 5030, respectively) originated by Ken Johnson. The NOAA/PMEL R/V Malcolm Baldrige CGC-90 Cruise data set is available without charge as a numeric data package (NDP) from the Carbon Dioxide Information Analysis Center. The NDP consists of two oceanographic data files, two FORTRAN 77 data retrieval routine files, a "readme" file, and this printed documentation, which describes the contents and format of all files as well as the procedures and methods used to obtain the data.

30776 (ORNL/TM–13071) **TERRAIN: A computer program to process digital elevation models for modeling surface flow.** Schwartz, P.M. (Oak Ridge National Lab., TN (United States). Environmental Sciences Div.); Levine, D.A.; Hunsaker, C.T.; Timmins, S.P. Oak Ridge National Lab., TN (United States). Aug 1995. 59p. Sponsored by USDOE, Washington, DC (United States). DOE Contract AC05-84OR21400. Order Number DE96000832. Source: OSTI; NTIS; GPO Dep.

Environmental Sciences Division Publication Number 4455.

This document provides a step by step procedure, TERRAIN, for processing digital elevation models to calculate overland flow paths, watershed boundaries, slope, and aspect. The algorithms incorporated into TERRAIN have been used at two different geographic scales: first for small research watersheds where surface wetness measurements are made, and second for regional water modeling for entire counties. For small areas methods based on flow distribution may be more desirable, especially if time-dependent flow models are to be used. The main improvement in TERRAIN compared with earlier programs on which it is based is that it combines the conditioning routines, which remove depressions to avoid water storage, into a single process. Efficiency has also been improved, reducing run times as much as 10:1 and enabling the processing of very large grids in strips for regional modeling. Additionally, the ability to calculate the nutrient load delivered any cell in a watershed has been added. These improvements make TERRAIN a powerful tool for modeling surface flow.

30777 (SMHI-RH–10) **Conceptual modelling of evapotranspiration for simulations of climate change effects.** Lindstroem, G.; Gardelin, M.; Persson, Magnus. Swedish Meteorological and Hydrological Inst., Norrkoeping (Sweden). Sep 1994. 31p. Order Number DE96703707. Source: OSTI; NTIS.

The evapotranspiration routines in existing conceptual hydrological models have been identified as one of the weaknesses which appear when these models are used for the simulation of hydrological effects of a changing climate. The hydrological models in operational use today usually have a very superficial description of evapotranspiration. They have, nevertheless, been able to yield reasonable results. The objective of this paper is to analyse and suggest modifications of existing evapotranspiration routines in conceptual hydrological models to make them more appropriate for use in simulation of the effects of a changing climate on water resources. The following modifications of the evapotranspiration routine were formulated and tested in the HBV model: Temperature anomaly correction of evapotranspiration, potential evapotranspiration by a simplified Thornthwaite type formula, interception submodel, spatially distributed evapotranspiration routine and alternative formulations of lake evapotranspiration. Sensitivity analyses were thereafter made to illustrate the effects of uncertainty in the hydrological model structure versus those of the uncertainty in the climate change predictions. 34 refs, 15 figs, 6 tabs

30778 (UCRL-ID–118678) **Preliminary report on the groundwater isotope study in the Brentwood Region.** Davisson, M.L. (Lawrence Livermore National Lab., CA (United States)); Campbell, K.R. Lawrence Livermore National Lab., CA (United States). 12 Oct 1994. 25p. Sponsored by USDOE, Washington, DC (United States). DOE Contract W-7405-ENG-48. Order Number DE95017038. Source: OSTI; NTIS; GPO Dep.

Under contract with the City of Brentwood and auxiliary support by the East Contra Costa Irrigation District (ECCID), a preliminary research assessment of the groundwater resources beneath the Brentwood region is complete. The research was performed by an isotope geochemistry approach rather than traditional hydrogeological methods. The isotope approach is inexpensive relative to the traditional methods and has been used here mostly as a tracer that details the source, migration paths, and migration rates of existing

groundwater supplies. In addition, the isotope results provide a quantitative framework in which to answer questions important to Brentwood including: (1) What is the long-term and short-term sustainability of the groundwater resources relative to current urban growth projections? (2) How can the good water quality be maximized in groundwater wells under short and long-term groundwater use schemes? (3) What underground areas exist within the Brentwood region that indicate untapped groundwater supplies that may provide plentiful, good quality water? This preliminary report focuses only on the first question. The second and third questions will be addressed in the final report to be completed by January 1, 1995. Furthermore, the conclusions in this preliminary report of how much groundwater is available for use will be incorporated into the Groundwater Management Plan currently being developed by the ECCID in conjunction with the City of Brentwood.

30779 (UCRL-ID–121682) **LLNL data collection during NOAA/ETL COPE experiment.** Mantrom, D.D. Lawrence Livermore National Lab., CA (United States). 6 Sep 1995. 6p. Sponsored by USDOE, Washington, DC (United States). DOE Contract W-7405-ENG-48. Order Number DE96000881. Source: OSTI; NTIS; GPO Dep.

COPE is the acronym for the Coastal Ocean Probe Experiment, to be conducted by NOAA/ETL off the northern Oregon coast in September–October 1995. In general terms, ETL desires to collect data on how various types of microwave sensors including radar would respond to internal wave-induced modulations to the ocean surface, and what effects propagation through the atmosphere might have on the data collected. In COPE, ETL will field a broad suite of microwave sensors, and a variety of sea-truth and atmospheric-truth instruments. These will include a land-based, high power, X and Ka-band real aperture radar (RAR) located atop a 3,000 ft high coastal peak, various water column, surface wave, air-sea interface, and atmospheric sensors on the FLIP measurement platform to be moored approximately 15 miles offshore, various active and passive microwave devices onboard a blimp which will fly at 6,000–8,000 ft altitude, two ground-based CODARs that measure large-scale surface currents, various wind profilers, and others. Lawrence Livermore National Laboratory's Imaging and Detection Program will take advantage of this unique site and opportunity to collect imagery with the radar that will be well ground-truthed with subsurface, surface, and above-water environmental data and possibly be compared to radar image data collected simultaneously or nearly simultaneously with another radar. Specifically, the authors are planning to conduct a short data collection with their Airborne Experimental Test Bed (AETB) jet aircraft-based X-band, HH-polarization synthetic aperture radar (SAR) as a piggyback to the planned COPE operation.

30780 (UCRL-ID–121951) **Uncertainties in global ocean surface heat flux climatologies derived from ship observations.** Gleckler, P.J. (Lawrence Livermore National Lab., CA (United States)); Weare, B.C. Lawrence Livermore National Lab., CA (United States). Aug 1995. 40p. Sponsored by USDOE, Washington, DC (United States). DOE Contract W-7405-ENG-48. Order Number DE96001026. Source: OSTI; NTIS; GPO Dep.

PCMDI Report Number 26.

A methodology to define uncertainties associated with ocean surface heat flux calculations has been developed and applied to a revised version of the Oberhuber global climatology, which utilizes a summary of the COADS surface observations. Systematic and random uncertainties in the net oceanic heat flux and each of its four components at individual grid points and for zonal averages have been estimated for each calendar month and the annual mean. The most important uncertainties of the 2° x 2° grid cell values of each of the heat fluxes are described. Annual mean net shortwave flux random uncertainties associated with errors in estimating cloud cover in the tropics yield total uncertainties which are greater than 25 W m^{-2}. In the northern latitudes, where the large number of observations substantially reduce the influence of these random errors, the systematic uncertainties in the utilized parameterization are largely responsible for total uncertainties in the shortwave fluxes which usually remain greater than 10 W m^{-2}. Systematic uncertainties dominate in the zonal means because spatial averaging has led to a further reduction of the random errors. The situation for the annual mean latent heat flux is somewhat different in that even for grid point values the contributions of the systematic uncertainties tend to be larger than those of the random uncertainties at most all latitudes. Latent heat flux uncertainties are greater than 20 W m^{-2} nearly everywhere south of 40°N, and in excess of 30 W m^{-2} over broad areas of the subtropics, even those with large numbers of observations. Resulting zonal mean latent heat flux uncertainties are largest (~30 W m^{-2}) in the middle latitudes and subtropics and smallest (~10–25 W m^{-2}) near the equator and over the northernmost regions.

30781 (UCRL-ID–122013) **Loch Linnhe '94: Current meter array operations and on-site analysis.** Chambers, D.H.; Jones, H.E. Lawrence Livermore National Lab., CA (United States). 11 Aug 1995. 64p. Sponsored by USDOE, Washington, DC (United States). DOE Contract W-7405-ENG-48. Order Number DE96000375. Source: OSTI; NTIS; GPO Dep.

This report documents the operation and on-site data analysis of the LLNL Current Meter Array (CMA) which was fielded at Loch Linnhe '94. The CMA is a large floating array of 10 sensors which measure horizontal current near the water surface. The measurements are used to interpret radar images of the water surface. This experiment was conducted as a part of the Joint UK/US Radar Ocean Imaging (ROI) Program. It was held at Loch Linnhe, Scotland in September 1994. The experiment consisted of measuring natural and ship-generated internal waves (IWs) in Loch Linnhe and imaging them with a land-based, dual frequency, dual-polarization real aperture radar operated by the UK. The goal was to determine the relationship between the amplitude of IWs as measured by instrumentation deployed in the water and the modulation they produce in radar images of the water surface.

30782 (WSRC-RP–95-722) **Surface Water Transport for the F/H Area Seepage Basins Groundwater Program.** Chen, Kuo-Fu. Westinghouse Savannah River Co., Aiken, SC (United States). 29 Aug 1995. 20p. Sponsored by USDOE, Washington, DC (United States). DOE Contract AC09-89SR18035. Order Number DE96060010. Source: OSTI; NTIS; INIS; GPO Dep.

The contribution of the F- and H-Area Seepage Basins (FHSBs) tritium releases to the tritium concentration in the Savannah River are presented in this report. WASP5 was used to simulate surface water transport for tritium releases from the FHSBs. The WASP5 model was qualified with the 1993 tritium measurements at US Highway 301. The tritium concentrations in Fourmile Branch and the Savannah River were calculated for tritium releases from FHSBs. The calculated tritium concentrations above normal environmental background in the Savannah River, resulting from FHSBs releases, drop from 1.25 pCi/ml (<10% of EPA Drinking Water Guide) in 1995 to 0.0056 pCi/ml in 2045.

30783 (Y/EN–5276/Rev.1) **Engineering report for the Central Mercury Treatment System. Revision 1.** Oak Ridge Y-12 Plant, TN (United States). Mar 1995. 12p. Sponsored by USDOE, Washington, DC (United States). DOE Contract AC05-84OR21400. Order Number DE96000403. Source: OSTI; NTIS; GPO Dep.

Mercury was used at the Oak Ridge Y-12 Plant between 1950 and 1963. The legacy of contamination resulting from use and storage of mercury has prompted a series of remedial measures. Since the mid 1980s, a series of engineered projects, maintenance activities, and general improvement in work practices has resulted in a decreasing trend of mercury concentration in East Fork Poplar Creek (EFPC). Some of the mercury in the soils surrounding past mercury-use buildings enters the building sumps which are discharged to the EFPC. The overall goal of increased environmental quality management is to reduce the mercury contamination of the EFPC to no more than 5 g/day. This project will create the Central Mercury Treatment System (CMTS) to reduce the mercury contribution to the EFPC by installing carbon adsorption units to treat the effluent from buildings 9201-4, 9201-5 and 9204-4. The use of carbon adsorption will be the long-term strategy for reduction of mercury in plant effluent.

30784 (Y/SUB–92-TK532C/4) **Radiological monitoring plan for the Oak Ridge Y-12 Plant: Surface water.** Oak Ridge Y-12 Plant, TN (United States); H and R Technical Associates, Inc., Oak Ridge, TN (United States). 25 Jul 1995. 70p. Sponsored by

USDOE, Washington, DC (United States). DOE Contract AC05-84OS21400. Order Number DE96000402. Source: OSTI; NTIS; INIS; GPO Dep.

National Pollutant Discharge Elimination System (NPDES) Permit TN0002968, issued April 28, 1995, requires that the Y-12 Plant Radiological Monitoring Plan for surface water be modified (Part 111-H). These modifications shall consist of expanding the plan to include storm water monitoring and an assessment of alpha, beta, and gamma emitters. In addition, a meeting was held with personnel from the Tennessee Department of Environment and Conservation (TDEC) on May 4, 1995. In this meeting, TDEC personnel provided guidance to Y-12 Plant personnel in regard to the contents of the modified plan. This report contains a revised plan incorporating the permit requirements and guidance provided by TDEC personnel. In addition, modifications were made to address future requirements of the new regulation for radiation protection of the public and the environment in regards to surface water monitoring.

55 BIOMEDICAL SCIENCES, BASIC STUDIES

Refer also to citation(s) 30631

5501 Behavioral Biology

Refer also to citation(s) 30326, 30701, 30705

30785 (EGG–11265-1135) **Food item use by coyote sex and age classes.** Cypher, B.L.; Spencer, K.A.; Scrivner, J.H. EG and G Energy Measurements, Inc., Tupman, CA (United States). [1995]. 10p. Sponsored by USDOE, Washington, DC (United States). DOE Contract AC08-93NV11265. Order Number DE96000168. Source: OSTI; NTIS; GPO Dep.

Food item use by coyotes was compared between sexes and among age classes at the Naval Petroleum Reserves, California. Item use did not differ significantly between males and females. Although leporid was the item most frequently used by all age classes, item use differed significantly between pups (< 1 year), yearlings (1 year), and adults (> 1 year), probably due to differential use of secondary items. Variation in item use among age classes could potentially bias results of coyote food habit studies.

5502 Biochemistry

Refer also to citation(s) 28743, 29376, 29377, 30671, 30797

30786 (BNL–62179) **The human DNA-activated protein kinase, DNA-PK: Substrate specificity.** Anderson, C.W. (Brookhaven National Lab., Upton, NY (United States). Biology Dept.); Connelly, M.A.; Zhang, H.; Sipley, J.A.; Lees-Miller, S.P.; Lintott, L.G.; Sakaguchi, Kazuyasu; Appella, E. Brookhaven National Lab., Upton, NY (United States). 5 Nov 1994. 30p. Sponsored by USDOE, Washington, DC (United States);Natural Sciences and Engineering Research Council of Canada, Ottawa, ON (Canada);Alberta Cancer Board, AB (Canada). DOE Contract AC02-76CH00016. Order Number DE96000414. Source: OSTI; NTIS; GPO Dep.

Although much has been learned about the structure and function of p53 and the probable sequence of subsequent events that lead to cell cycle arrest, little is known about how DNA damage is detected and the nature of the signal that is generated by DNA damage. Circumstantial evidence suggests that protein kinases may be involved. In vitro, human DNA-PK phosphorylates a variety of nuclear DNA-binding, regulatory proteins including the tumor suppressor protein p53, the single-stranded DNA binding protein RPA, the heat shock protein hsp90, the large tumor antigen (TAg) of simian virus 40, a variety of transcription factors including Fos, Jun, serum response factor (SRF), Myc, Sp1, Oct-1, TFIID, E2F, the estrogen receptor, and the large subunit of RNA polymerase II (reviewed in Anderson, 1993; Jackson et al., 1993). However, for most of these proteins, the sites that are phosphorylated by DNA-PK are not known. To determine if the sites that were phosphorylated in vitro also were phosphorylated in vivo and if DNA-PK recognized a preferred protein sequence, the authors identified the sites phosphorylated by DNA-PK in several substrates by direct protein sequence analysis. Each phosphorylated serine or threonine is followed immediately by glutamine in the polypeptide chain; at no other positions are the amino acid residues obviously constrained.

30787 (CONF-9506258–1) **Laser desorption mass spectrometry for fast DNA analysis.** Chen, C.H.; Ch'ang, L.Y.; Taranenko, N.I.; Allman, S.L.; Tang, K.; Matteson, K.J. Oak Ridge National Lab., TN (United States). [1995]. 9p. Sponsored by USDOE, Washington, DC (United States). DOE Contract AC05-84OR21400. From Chinese-American Academic and Professional Association in United States (CAPASUS) conference; Atlanta, GA (United States); 23-25 Jun 1995. Order Number DE95017392. Source: OSTI; NTIS; GPO Dep.

During the past few years, major effort has been directed toward developing mass spectrometry to measure biopolymers because of the great potential benefit to biomedical research. Hellenkamp and his co-workers were the first to report that large polypeptide molecules can be ionized and detected without significant fragmentation when a greater number of nicotinic acid molecules are used as a matrix. This method is now well known as matrix-assisted laser desorption/ionization (MALDI). Since then, various groups have reported measurements of very large proteins by MALDI. Reliable protein analysis by MALDI is more or less well established. However, the application of MALDI to nucleic acids analysis has been found to be much more difficult. Most research on the measurement of nucleic acid by MALDI were stimulated by the Human Genome Project. Up to now, the only method for reliable routine analysis of nucleic acid is gel electrophoresis. Different sizes of nucleic acids can be separated in gel medium when a high electric field is applied to the gel. However, the time needed to separate different sizes of DNA segments usually takes from several minutes to several hours. If MALDI can be successfully used for nucleic acids analysis, the analysis time can be reduced to less than I millisecond. In addition, no tagging with radioactive materials or chemical dyes is needed. In this work, we will review recent progress related to MALDI for DNA analysis.

30788 (DOE/ER/14047–18) **Understanding and targeting a novel plant viral proteinase/substrate interaction. Final report, July 1, 1989–June 30, 1995.** Dougherty, W. Oregon State Univ., Corvallis, OR (United States). Dept. of Microbiology. [1995]. 3p. Sponsored by USDOE, Washington, DC (United States). DOE Contract FG06-89ER14047. Order Number DE96000245. Source: OSTI; NTIS; GPO Dep.

The past 3 years of funding have focused our efforts on trying to understand the molecular basis of a unique substrate interaction displayed by a viral proteinase. We have made good progress and during this funding period we have made four contributions to the scientific literature and have developed the application of the proteinase in the expression and purification of recombinant fusion proteins. A comprehensive review of virus-encoded proteinases, written during the funding period, emphazing the tremendous similarity of viral proteinases with their cellular counterparts and at the same time detail the unique characteristics which permit them to function in a cellular environment. The focus of the research effort was the tobacco etch virus (TEV) 27kDa NIa proteinase.

30789 (LA-UR–95-2785) **Solution assembly of cytokine receptor ectodomain complexes.** Wu, Zining (Dartmouth Medical School, Hanover, NH (United States). Dept. of Pharmacology and Toxicology); Ciardelli, T.L.; Johnson, K.W. Los Alamos National Lab., NM (United States). 1995. 12p. Sponsored by National Insts. of Health, Bethesda, MD (United States);American Cancer Society, New York, NY (United States);National Science Foundation, Washington, DC (United States);Veterans Administration, Washington, DC (United States);Hitchcock Founda DOE Contract W-7405-ENG-36. (CONF-9507177–1: 9. Protein Society symposium, Boston, MA (United States), 8-12 Jul 1995). Order Number DE96000020. Source: OSTI; NTIS; GPO Dep.

For the majority of single transmembrane-spanning cell surface receptors, signal transmission across the lipid bilayer barrier involves several discrete components of molecular recognition. The

interaction between ligand and the extracellular segment of its cognate receptor (ectodomain) initiates either homomeric or heteromeric association of receptor subunits. Specific recognition among these subunits may then occur between ectodomain regions, within the membrane by interhelical contact or inside the cell between cytoplasmic domains. Any or all of these interactions may contribute to the stability of the signaling complex. It is the characteristics of ligand binding by the ectodomains of these receptors that controls the heteromeric or homomeric nature and the stoichiometry of the complex. Cytokines and their receptors belong to a growing family of macromolecular systems that exhibit these functional features and share many structural similarities as well. Interleukin-2 is a multifunctional cytokine that represents, perhaps, the most complex example to date of ligand recognition among the hematopoietin receptor family. It is the cooperative binding of IL-2 by all three proteins on the surface of activated T-lymphocytes, however, that ultimately results in crosslinking of the β- and γ-subunits and signaling via association of their cytoplasmic domains. Although the high-affinity IL-2R functions as a heterotrimer, heterodimers of the receptor subunits are also physiologically important. The α/β heterodimer or "pseudo-high affinity" receptor captures IL-2 as a preformed cell surface complex while the β/γ intermediate affinity site exists, in the absence of the α subunit, on the majority of natural killer cells. We have begun to study stable complexes of cytokine receptor ectodomains of defined composition and that mimic the ligand binding characteristics of the equivalent cell surface receptor sites.

30790 (LA-UR–95-2962) **Diffusion of a protein in configuration space.** Garcia, A.E.; Blumenfeld, R.; Hummer, G.; Sobehart, J. Los Alamos National Lab., NM (United States). [1995]. 27p. Sponsored by USDOE, Washington, DC (United States). DOE Contract W-7405-ENG-36. (CONF-9506267–1: 9. conversation in biomolecular stereodynamics, Albany, NY (United States), 20-24 Jun 1995). Order Number DE96000024. Source: OSTI; NTIS; GPO Dep.

Simulations of biomolecular dynamics are commonly interpreted in terms of harmonic or quasi-harmonic models for the dynamics of the system. These models assume that biomolecules exhibit oscillations around a single energy minimum. However, spectroscopic data on myoglobin suggest that proteins sample multiple minima. Transitions between minima reveal a broad distribution of energy barriers. This behavior has been observed in other biomolecular systems. To elucidate the nature of protein dynamics the authors have studied a 1.2ns molecular dynamics trajectory of crambin in aqueous solution. This trajectory samples multiple local energy minima. Transitions between minima involve collective motions of amino acids over long distances. The authors show that nonlinear motions are responsible for most of the atomic fluctuations of the protein. These atomic fluctuations are not well described by large motions of individual atoms or a small group of atoms, but rather by concerted motions of many atoms. These nonlinear motions describe transitions between different basins of attraction. The signature of these motions manifests in local and global structural variables. A method for extracting Molecule Optimal Dynamic Coordinates (MODC) is presented.

30791 (NEDO-IT–9303) **Investigation of the creation of functional surfaces and the recent development in related researches. 2. Investigation of the development of new isolation/refining systems in water system.** New Energy and Industrial Technology Development Organization, Tokyo (Japan). Mar 1994. 135p. (In Japanese). Order Number DE96704377. Source: OSTI; NTIS; Available from New Energy and Industrial Technology Development Organization, Sunshine 60, 30F 1-1, 3-chome, Higashi-Ikebukuro, Toshima-ku, Tokyo, Japan.

Propositions were made concerning new chromatography and membrane separation techniques wherein a command control material is used, the mobile phase is fixed upon water, and the fixed phase is caused to vary by external commands, and how to develop the said techniques into a project was discussed. New methods were also introduced, capable of separating water systems and, particularly, capable of separating and refining, without damaging their functions, bionic elements such as proteins, genes, and cells, which encouraged discussion on the future of the said project. As for command controlled materials, detailed investigations were conducted into materials responsive to physical stimulation such as light, electric field, magnetic field, or heat and materials responsive to PH and chemical or biochemical substances, and discussion was made on the structures and characters of the said materials. Concerning the manufacture of a command controlled surface, consideration centered particularly about the density and thickness of command controlled molecules to be introduced onto the surface. Furthermore, the current state and problems were discussed regarding chromatographic separation and refining of optical isomers, nucleic acids, physiologically active substances, peptides, cells, etc. 252 refs., 75 figs., 31 tabs.

30792 (NEDO-IT–9305) **Investigation of technology for structuring acceleration type biological functions.** New Energy and Industrial Technology Development Organization, Tokyo (Japan). Mar 1994. 101p. (In Japanese). Order Number DE96704379. Source: OSTI; NTIS; Available from New Energy and Industrial Technology Development Organization, Sunshine 60, 30F 1-1, 3-chome, Higashi-Ikebukuro, Toshima-ku, Tokyo, Japan.

Investigation and examination were conducted of the current state and future possibilities of evolutive molecular engineering. It has been learned that studies of mutation generating means, domestic and international, deal mainly with point mutation; that large-scale mutation for example by randomization or exon shuffling remains a task to be undertaken in future; that the techniques for enabling mutation related genetic information and phenotypic characters to successfully correspond to conditions inside and outside a living body and the methods for selecting and evaluating phenotypic characters are still at the initial stage of development; and that the efforts for developing basic techniques common to the related fields, such as an evolution related experimentation simulation and a method for evaluating the direction of evolution, efforts for developing a total system for experimentation, are not beyond the basic researches under way at university or the like. It has been concluded that, before the study being discussed here is developed into a project, key technologies such as an evolution experimenting system for nucleic acids, peptides, and proteins have to be constructed and an evolution experimenting simulation, a method for evaluating the direction of evolution, and a total system for the experimentation of evolution have to be developed. 167 refs., 35 figs., 1 tab.

30793 (NREL/CP–200-8098, pp. 785-790) **The anaerobic digestion process.** Rivard, C.J. (National Renewable Energy Lab., Golden, CO (United States)); Boone, D.R. National Renewable Energy Lab., Golden, CO (United States). [1995]. (CONF-9508104–: 2. meeting on biomass of the Americas, Portland, OR (United States), 21-24 Aug 1995). In *Second biomass conference of the Americas: Energy, environment, agriculture, and industry. Proceedings.* 1741p. Order Number DE95009230. Source: OSTI.

The microbial process of converting organic matter into methane and carbon dioxide is so complex that anaerobic digesters have long been treated as "black boxes". Research into this process during the past few decades has gradually unraveled this complexity, but many questions remain. The major biochemical reactions for forming methane by methanogens are largely understood, and evolutionary studies indicate that these microbes are as different from bacteria as they are from plants and animals. In anaerobic digesters, methanogens are at the terminus of a metabolic web, in which the reactions of myriads of other microbes produce a very limited range of compounds-mainly acetate, hydrogen, and formate-on which the methanogens grow and from which they form methane. "Interspecies hydrogen-transfer" and "interspecies formate-transfer" are major mechanisms by which methanogens obtain their substrates and by which volatile fatty acids are degraded. Our understanding of these reactions and other complex interactions among the bacteria involved in anaerobic digestion is only now to the point where anaerobic digesters need no longer be treated as black boxes.

30794 (SAND–95-8258) **CCEMD: Center for Computational Engineering Molecular Dynamics. Theory and user's guide, Version 2.2.** Judson, R. (Sandia National Labs., Albuquerque, NM (United States)); Barsky, D.; Faulkner, T.; McGarrah, D.; Melius,

C.; Meza, J.; Mori, E.; Plantenga, T.; Windemuth, A. Sandia National Labs., Albuquerque, NM (United States). 18 Sep 1995. 51p. Sponsored by USDOE, Washington, DC (United States). DOE Contract AC04-94AL85000. Order Number DE96000869. Source: OSTI; NTIS; GPO Dep.

CCEMD (Center for Computational Engineering Molecular Dynamics) is a general purpose molecular dynamics program written in the C language, built on top of the MD program of Windemuth and Schulten. CCEMD can perform molecular dynamics, gradient minimization, genetic algorithm-based conformation searching, and ligand-protein docking. This report documents the algorithms used and provides a users' guide for the code.

30795 (UCRL-ID–114972-2, pp. 16, Paper 3) **Separation of a chemically modified DNA oligomer bound by the carcinogen 2-Amino-1-methy-6-phenylimidazo [4,5-β]pyridine using capillary gel electrophoresis.** Nguyen, T.N. (California Polytechnic State Univ., San Luis Obispo, CA (United States)). Lawrence Livermore National Lab., CA (United States). 6 May 1994. (CONF-9405328–Absts.: Science and Engineering Research Semester (SERS) student symposium, Livermore, CA (United States), 6 May 1994). In *SERS intership: Spring 1994 abstracts and research papers.* 195p. Order Number DE95014118. Source: OSTI; NTIS; GPO Dep.

We have optimized the reaction conditions under which unactivated metabolite of the food borne carcinogen 2-amino-1-methyl-6-phenylimidazo [4,5-β]pyridine (PhIP) is covalently bound to the oligodeoxynucleotide d(CCTACGCATCC). Capillary electrophoresis (CE) was used to separate and characterize this DNA oligomer bound by PhIP. We observed 2 major and several minor PhIP adduct species. The 2 major adducts had different absorbance maxima; the major adduct eluates with faster and slower mobilities had absorbance maxima of 360 and 340 nm, respectively. One of the two major PhIP adduct species was resolvable but the peak was broad. Using detection at 260 nm, the other major PhIP adduct with fastest electrophoretic mobility was not resolvable, but coelute with the huge broad unmodified DNA oligomer peak. However, at higher wavelengths (>320 nm) where DNA does not absorb, electropherograms generated by detection at these higher wavelengths showed very heterogeneous binding by PhIP to the DNA oligomer with no interfering absorbance by the DNA.

30796 (UCRL-ID–119660) **Advanced microinstrumentation for rapid DNA sequencing and large DNA fragment separation.** Balch, J.; Davidson, J.; Brewer, L.; Gingrich, J.; Koo, J.; Mariella, R.; Carrano, A. Lawrence Livermore National Lab., CA (United States). 25 Jan 1995. 12p. Sponsored by USDOE, Washington, DC (United States). DOE Contract W-7405-ENG-48. Order Number DE95017042. Source: OSTI; NTIS; GPO Dep.

Our efforts to develop novel technology for a rapid DNA sequencer and large fragment analysis system based upon gel electrophoresis are described. We are using microfabrication technology to build dense arrays of high speed micro electrophoresis lanes that will ultimately increase the sequencing rate of DNA by at least 100 times the rate of current sequencers. We have demonstrated high resolution DNA fragment separation needed for sequencing in polyacrylamide microgels formed in glass microchannels. We have built prototype arrays of microchannels having up to 48 channels. Significant progress has also been made in developing a sensitive fluorescence detection system based upon a confocal microscope design that will enable the diagnostics and detection of DNA fragments in ultrathin microchannel gels. Development of a rapid DNA sequencer and fragment analysis system will have a major impact on future DNA instrumentation used in clinical, molecular and forensic analysis of DNA fragments.

5503 Cytology

Refer also to citation(s) 30791, 30842

30797 (BNL–61925) **Silver enhancement of nanogold and undecagold.** Hainfield, J.F.; Furuya, F.R. Brookhaven National Lab., Upton, NY (United States). [1995]. 54p. Sponsored by USDOE, Washington, DC (United States). DOE Contract AC02-76CH00016. Order Number DE95014945. Source: OSTI; NTIS; GPO Dep.

A recent advance in immunogold technology has been the use of molecular gold instead of colloidal gold. A number of advantages are realized by this approach, such as stable covalent, site-specific attachment, small probe size and absence of aggregates for improved penetration. Silver enhancement has led to improved and unique results for electron and light microscopy, as well as their use with blots and gels. Most previous work with immunogold silver staining has been done with colloidal gold particles. More recently, large gold compounds ("clusters") having a definite number of gold atoms and defined organic shell, have been used, frequently with improved results. These gold dusters, large compared to simple compounds, are, however, at the small end of the colloidal gold scale in size; undecagold is 0.8 nm and Nanogold is 1.4 nm. They may be used in practically all applications where colloidal gold is used (Light and electron microscopy, dot blots, etc.) and in some unique applications, where at least the larger colloidal golds don't work, such as running gold labeled proteins on gels (which are later detected by silver enhancement). The main differences between gold clusters and colloidal golds are the small size of the dusters and their covalent attachment to antibodies or other molecules.

5504 Genetics

Refer also to citation(s) 29227, 29364, 29365, 30792, 30794, 30796, 31329

30798 (DOE/ER/61674–1) **Genome sequencing and analysis conferences. Progress report, August 15, 1993–August 15, 1994.** Venter, J.C. Institute for Genomic Research, Gaithersburg, MD (United States). [1995]. 6p. Sponsored by USDOE, Washington, DC (United States). DOE Contract FG02-93ER61674. Order Number DE96000287. Source: OSTI; NTIS; GPO Dep.

The 14 plenary session presentations focused on nematode; yeast; fruit fly; plants; mycobacteria; and man. In addition there were presentations on a variety of technical innovations including database developments and refinements, bioelectronic genesensors, computer-assisted multiplex techniques, and hybridization analysis with DNA chip technology. This document includes only the session schedule.

30799 (LA-SUB–95-111) **Algorithm for genome contig assembly. Final report.** Los Alamos National Lab., NM (United States). [1995]. 5p. Sponsored by USDOE, Washington, DC (United States). DOE Contract W-7405-ENG-36. Order Number DE95017811. Source: OSTI; NTIS; GPO Dep.

An algorithm was developed for genome contig assembly which extended the range of data types that could be included in assembly and which ran on the order of a hundred times faster than the algorithm it replaced. Maps of all existing cosmid clone and YAC data at the Human Genome Information Resource were assembled using ICA. The resulting maps are summarized.

30800 (UCRL-ID–114972-2, pp. 14, Paper 4) **Identification of the genomic locus for the human Rieske Fe-S Protein gene on Chromosome 19q12.** Pennacchio, L.A. (Sonoma State Univ. (United States)). Lawrence Livermore National Lab., CA (United States). 6 May 1994. DOE Contract W-7405-ENG-48. (CONF-9405328–Absts.: Science and Engineering Research Semester (SERS) student symposium, Livermore, CA (United States), 6 May 1994). In *SERS intership: Spring 1994 abstracts and research papers.* 195p. Order Number DE95014118. Source: OSTI; NTIS; GPO Dep.

We have identified the chromosomal location of the human Rieske Iron-Sulfur Protein (UQCRFS1) gene. Mapping by hybridization to a panel of monochromosomal hybrid cell lines indicated that the gene was either on chromosome 19 or 22. By screening a human chromosome 19 specific genomic cosmid library with an oligonucleotide probe made from the published Rieske cDNA sequence, we identified a corresponding cosmid. Portions of this cosmid were sequenced directly. The exon, exon:intron junction, and flanking sequences verified that this cosmid contains the genomic locus. Fluorescent in situ hybridization (FISH) was performed to localize this cosmid to chromosome band 19q12.

5505 Metabolism

Refer also to citation(s) 28705, 29377

5506 Medicine

Refer also to citation(s) 29154, 29186

30801 (FERMILAB/TM–1940) **Low intensity configuration at NTF for microdosimetry and spectroscopy.** Kroc, T.K. Fermi National Accelerator Lab., Batavia, IL (United States). Sep 1995. 22p. Sponsored by USDOE, Washington, DC (United States). DOE Contract AC02-76CH03000. Order Number DE96000316. Source: OSTI; NTIS; INIS; GPO Dep.

Additional circuitry has been developed to regulate beam delivery to Fermilab's Neutron Therapy Facility. This allows the number of protons on target to be reduced to a point that makes microdosimetry and spectroscopy possible. An introduction to the problem is presented. The modifications are described and results verifying their effectiveness are reported.

30802 (INIS-BR–3546) **Basic aspects of scintiphotography for the encephalopathy studies in Canis familiaris L.** Ramadinha, L.S. Universidade Federal Rural do Rio de Janeiro, RJ (Brazil). Curso de Pos-graduacao em Patologia Veterinaria. 1988. 70p. (In Portuguese). Order Number DE96602666. Source: OSTI; NTIS; INIS.

The development of encephalic scintillography on dogs using intravenous administered radiotracer, was presented. The study was conducted by administrating 20 m Cu/99 mTc pertechnetate into the radial vein of 14 normal dogs; the tracer was detected externally on the encephalus using a computerized gamma camera. The static pictures were easily obtained in 4 standard positions and presents good information about encephalic morphology. (author). 29 refs, 15 figs, 3 tabs.

30803 (INIS-BR–3553) **Breast carcinoma conservative treatment. Stages I and II.** Monti, C.R. Universidade Estadual de Campinas, SP (Brazil). Faculdade de Ciencias Medicas. 1990. 139p. (In Portuguese). Order Number DE96602673. Source: OSTI; NTIS; INIS.

From 1981 to 1988, 265 patients with breast cancer stages I and II (UICC-1987), were evaluated after conservative treatment with quadrantectomy plus axillectomy, radiotherapy and chemotherapy. After surgical treatment, the patients were submitted to radiation therapy in the breast. One hundred and fifty six (58,8%) patients were submitted to adjuvant chemotherapy. The median clinical follow-up period was 42.8 months with a minimum of 24 and a maximum of 99 months. Six (2,3%) patients presented local recurrence and 48 (18,1%) presented distant metastasis. After five years the total survival rate was 89,7% and the disease free survival rate was 75% in the same period. The study did not show significant differences among the clinical stages classified after surgery and the use of adjuvant chemotherapy did not influence the results of the many stages. (author). 194 refs, 33 figs, 6 tabs.

30804 (LBL–37193) **Instrumentation in medical systems.** Chu, W.T. (Lawrence Berkeley Lab., CA (United States). Accelerator and Fusion Research Div.). Lawrence Berkeley Lab., CA (United States). May 1995. 5p. Sponsored by USDOE, Washington, DC (United States). DOE Contract AC03-76SF00098. (CONF-950512–317: Particle accelerator conference, Dallas, TX (United States), 1-5 May 1995). Order Number DE96000118. Source: OSTI; NTIS; INIS; GPO Dep.

The demand for clinical use of accelerated heavy charged-particle (proton and light-ion) beams for cancer treatment is now burgeoning worldwide. Clinical trials are underway at more than a dozen accelerators. Several hospital-based accelerator facilities dedicated to radiation treatment of human cancer have been constructed, and their number is growing. Many instruments in medical systems have been developed for modifying extracted particle beams for clinical application, monitoring the delivery of the treatment beams, and controlling the treatment processes to ensure patient safety. These in turn demand new developments of instruments in controlling beam extraction, beam tuning, and beam transportation at the medical systems.

30805 (LBL–37402) **Tradeoffs between measurement residual and reconstruction error in inverse problems with prior information.** Hughett, P. (Lawrence Berkeley Lab., CA (United States). Life Sciences Div.). Lawrence Berkeley Lab., CA (United States). Jun 1995. 12p. Sponsored by USDOE, Washington, DC (United States). DOE Contract AC03-76SF00098. (CONF-9507171–1: Experimental and numerical methods for solving ill-posed problems, San Diego, CA (United States), 9-14 Jul 1995). Order Number DE96000120. Source: OSTI; NTIS; GPO Dep.

In many inverse problems with prior information, the measurement residual and the reconstruction error are two natural metrics for reconstruction quality, where the measurement residual is defined as the weighted sum of the squared differences between the data actually measured and the data predicted by the reconstructed model, and the reconstruction error is defined as the sum of the squared differences between the reconstruction and the truth, averaged over some a priori probability space of possible solutions. A reconstruction method that minimizes only one of these cost functions may produce unacceptable results on the other. This paper develops reconstruction methods that control both residual and error, achieving the minimum residual for any fixed error or vice versa. These jointly optimal estimators can be obtained by minimizing a weighted sum of the residual and the error; the weights are determined by the slope of the tradeoff curve at the desired point and may be determined iteratively. These results generalize to other cost functions, provided that the cost functions are quadratic and have unique minimizers; some results are obtained under the weaker assumption that the cost functions are convex. This paper applies these results to a model problem from biomagnetic source imaging and exhibits the tradeoff curve for this problem.

30806 (LBL–37749) **The statistical efficiency of filtered backprojection in emission tomography.** Kuruc, A. Lawrence Berkeley Lab., CA (United States). 25 Sep 1995. 33p. Sponsored by USDOE, Washington, DC (United States). DOE Contract AC03-76SF00098. Order Number DE96001015. Source: OSTI; NTIS; GPO Dep.

While there has been much interest in developing tomographic reconstruction algorithms that are more statistically efficient than filtered backprojection (FB), the degree of improvement possible has not been well understood. We present an algorithm-independent theory of statistical accuracy attainable in emission tomography that provides a geometrical interpretation of the statistical efficiency of FB. Our analysis shows that, in general, one can build unbiased estimators with smaller variance than FB. The improvement in performance is obtained by exploiting the range properties of the Radon transform.

30807 (NUREG/CR–6323) **Relative risk analysis in regulating the use of radiation-emitting medical devices. A preliminary application.** Jones, E.D. (Lawrence Livermore National Lab., CA (United States)); Banks, W.W.; Altenbach, T.J.; Fischer, L.E. Nuclear Regulatory Commission, Washington, DC (United States). Div. of Industrial and Medical Nuclear Safety; Lawrence Livermore National Lab., CA (United States). Sep 1995. 164p. Sponsored by Nuclear Regulatory Commission, Washington, DC (United States). DOE Contract W-7405-ENG-48. (UCRL-ID–120051). Source: OSTI; NTIS; INIS; GPO.

This report describes a preliminary application of an analysis approach for assessing relative risks in the use of radiation- emitting medical devices. Results are presented on human-initiated actions and failure modes that are most likely to occur in the use of the Gamma Knife, a gamma irradiation therapy device. This effort represents an initial step in a US Nuclear Regulatory Commission (NRC) plan to evaluate the potential role of risk analysis in regulating the use of nuclear medical devices. For this preliminary application of risk assessment, the focus was to develop a basic process using existing techniques for identifying the most likely risk contributors and their relative importance. The approach taken developed relative risk rankings and profiles that incorporated the type and quality of data available and could present results in an easily understood form. This work was performed by the Lawrence Livermore National Laboratory for the NRC.

30808 (SLAC-PUB–95-6939) **Low-energy x-ray dosimetry studies (7 to 17.5 keV) with synchroton radiation.** Ipe, N.E.

(and others); Bellamy, H.; Flood, J.R. Stanford Univ., CA (United States). Jun 1995. 10p. Sponsored by USDOE, Washington, DC (United States). DOE Contract AC03-76SF00515. (CONF-950708–1: 11. international conference on solid state dosimetry, Budapest (Hungary), 10-14 Jul 1995). Order Number DE95017728. Source: OSTI; NTIS; INIS; GPO Dep.

Unique properties of synchrotron radiation (SR), such as its high intensity, brightness, polarization, and broad spectral distribution (extending from x-ray to infra-red wavelengths) make it an attractive light source for numerous experiments. As SR facilities are rapidly being built all over the world, they introduce the need for low-energy x-ray dosemeters because of the potential radiation exposure to experimenters. However, they also provide a unique opportunity for low-energy x-ray dosimetry studies because of the availability of monochromatic x-ray beams. Results of such studies performed at the Stanford Synchrotron Radiation Laboratory are described. Lithium fluoride TLDs (TLD-100) of varying thicknesses (0.015 to 0.08 cm) were exposed free in air to monochromatic x-rays (7 to 17.5 keV). These exposures were monitored with ionization chambers. The response (nC/Gy) was found to increase with increasing TLD thickness and with increasing beam energy. A steeper increase in response with increasing energy was observed with the thicker TLDs. The responses at 7 and 17.5 keV were within a factor of 2.3 and 5.2 for the 0.015 and 0.08 cm-thick TLDs, respectively. The effects of narrow (beam size smaller than the dosemeter) and broad (beam size larger than the dosemeter) beams on the response of the TLDs are also reported.

30809 (UCRL-CR–118475) **Quality Managment Program (QMP) report: A review of quality management programs developed in response to Title 10, Section 35.32 of the Code of Federal Regulations.** Witte, M.C. Lawrence Livermore National Lab., CA (United States). Oct 1994. 200p. Sponsored by Nuclear Regulatory Commission, Washington, DC (United States). DOE Contract W-7405-ENG-48. Order Number DE96000844. Source: OSTI; NTIS; INIS; GPO Dep.

In July of 1991, the Nuclear Regulatory Commission published a Final Rule in the Federal Register amending regulations governing medical therapeutic administrations of byproduct material and certain uses of radioactive sodium iodide. These amendments required implementation of a Quality Management Program (QMP) to provide high confidence that the byproduct material – or radiation from byproduct material – will be administered as directed by an authorized user physician. Herein, this rule is referred to as the QM rule. The Final Rule was published after two proposed rules had been published in the Federal Register.

30810 (UCRL-ID–114972-2, pp. 8, Paper 6) **Analysis of the acoustic spectral signature of prosthetic heart valves in patients experiencing atrial fibrillation.** Scott, D.D. (Lawrence Livermore National Laboratory, CA (United States)); Jones, H.E. Lawrence Livermore National Lab., CA (United States). 6 May 1994. (CONF-9405328–Absts.: Science and Engineering Research Semester (SERS) student symposium, Livermore, CA (United States), 6 May 1994). In *SERS intership: Spring 1994 abstracts and research papers.* 195p. Order Number DE95014118. Source: OSTI; NTIS; GPO Dep.

Prosthetic heart valves have increased the life span of many patients with life threatening heart conditions. These valves have proven extremely reliable adding years to what would have been weeks to a patient's life. Prosthetic valves, like the heart however, can suffer from this constant work load. A small number of valves have experienced structural fractures of the outlet strut due to fatigue. To study this problem a non-intrusive method to classify valves has been developed. By extracting from an acoustic signal the opening sounds which directly contain information from the outlet strut and then developing features which are supplied to an adaptive classification scheme (neural network) the condition of the valve can be determined. The opening sound extraction process has proved to be a classification problem itself. Due to the uniqueness of each heart and the occasional irregularity of the acoustic pattern it is often questionable as to the integrity of a given signal (beat), especially one occurring during an irregular beat pattern. A common cause of these irregular patterns is a condition known as atrial fibrillation, a prevalent arrhythmia among patients with prosthetic hear valves. Atrial fibrillation is suspected when the ECG shows no obvious P-waves. The atria do not contract and relax correctly to help contribute to ventricular filling during a normal cardiac cycle. Sometimes this leads to irregular patterns in the acoustic data. This study compares normal beat patterns to irregular patterns of the same heart. By analyzing the spectral content of the beats it can be determined whether or not these irregular patterns can contribute to the classification of a heart valve or if they should be avoided. The results have shown that the opening sounds which occur during irregular beat patterns contain the same spectral information as the opening which occur during a normal beat pattern of the same heart and these beats can be used for classification.

30811 (UCRL-ID–121808) **Design of a substrate heater for calcium hydroxyapatite coating by pulsed laser ablation.** Chang, T.; Havstad, M.A. Lawrence Livermore National Lab., CA (United States). 24 Jul 1995. 25p. Sponsored by USDOE, Washington, DC (United States). DOE Contract W-7405-ENG-48. (L–19757-1). Order Number DE96000839. Source: OSTI; NTIS; GPO Dep.

Calcium hydroxyapatite (HA) is the main chemical constituent of bone. When replacement hip joints are coated with this chemical, the body may be more likely to accept the artificial joint, forming new bone that bonds the joint to the original leg bone. HA deposited by laser ablation in vacuum adheres to the substrate better at high temperatures of up to 700 C. This heater should be capable of uniformly heating to 700 C a silicon disk 150 mm in diameter. The heater consists of two wire heating coils brazed into a disk of stainless steel, with tantalum shields on top and at the sides of the heater to minimize radiation loss. Three spring-rotation clamps at the bottom of the heater hold the substrate disk in place. This report describes the heater and how it was developed, including design evolution and thermal modeling. Also, detailed information about parts is discussed.

30812 (UCRL-JC–121246) **High resolution extremity CT for biomechanics modeling.** Ashby, A.E.; Brand, H.; Hollerbach, K.; Logan, C.M.; Martz, H.E. Lawrence Livermore National Lab., CA (United States). 23 Sep 1995. 5p. Sponsored by USDOE, Washington, DC (United States). DOE Contract W-7405-ENG-48. (CONF-9509207–1: 17. annual international conference of the Electrical & Electronics Engineers Engineering (IEEE) in Medicine & Biology Society (EMBS) and Canadian Medical & Biological Engineering Society (CMBES), Montreal (Canada), 20-23 Sep 1995). Order Number DE95015900. Source: OSTI; NTIS; INIS; GPO Dep.

With the advent of ever more powerful computing and finite element analysis (FEA) capabilities, the bone and joint geometry detail available from either commercial surface definitions or from medical CT scans is inadequate. For dynamic FEA modeling of joints, precise articular contours are necessary to get appropriate contact definition. In this project, a fresh cadaver extremity was suspended in parafin in a lucite cylinder and then scanned with an industrial CT system to generate a high resolution data set for use in biomechanics modeling.

5507 Microbiology

Refer also to citation(s) 30788

5510 Physiological Systems

Refer also to citation(s) 30806

5520 Public Health

Refer also to citation(s) 29345

5530 Agriculture and Food Technology

Refer also to citation(s) 30795

30813 (INIS-BR–3542) **Evaluation of the biological nitrogen fixation (N_2) contribution in several forage legumes and the**

transfer of N to associated grasses. Vargas, M.S.V. Universidade Federal Rural do Rio de Janeiro, RJ (Brazil). Curso de Pos-graduacao em Agronomia. Dec 1991. 200p. (In Portuguese). Order Number DE96602603. Source: OSTI; NTIS; INIS.

The objective of experiment 1 was to compare two different techniques for labelling the soil mineral nitrogen with ^{15} N, for studies to quantify the contribution of biological nitrogen fixation (BNF) to forage legumes using the ^{15} N isotope dilution technique. The two techniques for labelling the soil were: incorporation a ^{15} N labelled organic compost (slow release treatment), and split applications of ^{15} N labelled ammonium sulphate. The evaluation of the techniques was through the quantification of BNF in the Itaguai Hybrid of Centrosema using two non-Na- fixing control plants (P. maximum K K-16 and Sorghum bicolor). The objective of experiment 2 was to quantify the contribution of BNF to forage legumes and the transfer of fixed nitrogen to associated grasses in mixed swards again using the ^{15} N isotope dilution technique. This study was conducted on a red podzolic soil (Typic Hapludult), with 7 forage legumes and 3 grasses in monoculture, and 3 mixed swards of Brachiaria brizantha with the Centrosema hybrid, Galactia striata and Desmodium ovalifolium, respectively, with varying ratios of grass to legume (4:1 to 1:4). In order to quantify the BNF contributions to the legumes and the transfer of fixed N to the B. brizantha, the plots were amended 8 times with doses of 0.01 g ^{15} N m^{-2} of ^{15} N labelled ammonium sulphate (12.5 atom % ^{15} N) each 14 days, giving a total of 0.08 g ^{15} N m^{-2} of ^{15} N during the 97 days of the experiment. In monoculture the different forage legumes obtained the equivalent of between 43 and 100 kg N ha^{-1} from BNF. Stylosanthes guianensis showed the greatest contributions from BNF at 100 Kg N ha^{-1}. In mixed swards with Brachiaria brizantha the proportion of N derived from BNF in the three legumes studied (Centrosema hybrid, G. striata and D. ovalifolium) was significantly greater than when they were grown in monoculture. (author). 197 refs, 9 figs, 19 tabs.

30814 (INIS-BR–3545) **Serum levels of triiodothyronine (T_3) and thyroxine (T_4) in buffalo (Bubalus bubalis Lin.) raised in Amazon region.** Silva, A.O.A. da. Universidade Federal Rural do Rio de Janeiro, RJ (Brazil). Curso de Pos-graduacao em Patologia Veterinaria. Aug 1991. 102p. (In Portuguese). Order Number DE96602626. Source: OSTI; NTIS; INIS.

Through the use of radioimmunoassay (RIA) it was determined blood serum concentration of triiodothyronine (T_3) and thyroxine (T_4) (n=78) for two different water buffalo racial groups. Blood serum was collected from young and adult animals belonging to two farms in Castanhal country, state of Para, Brazil, through the year of 1988. The serum levels of T_3 and T_4 were statistically correlated with climatic parameters, e.g., pluviometric precipitation, environmental temperature, humidity, light intensity variation and physiological factors such as age, breed and sex. It was identified two seasons during experiment, one season the rainfall period with high precipitation rates and the other one was considered as dry season, with low precipitation rates. The average rate of temperature and humidity have shown no significant statistic difference between the two seasons. On the other hand, it was found a significant relationship between luminosity and seasons, since when the luminosity decreases the pluviometric rates increases. (author). 51 refs, 15 figs, 15 tabs.

30815 (INIS-mf–14556, pp. 14) **Use of Nuclear Techniques in Food, Agriculture and Pest Control.** Sigurbjornsson, B. Atomic Energy Establishment, Cairo (Egypt). Jun 1994. 84p. (CONF-9406263–: National seminar on nuclear energy in everyday life, Cairo (Egypt), 23-29 Jun 1994). In *National seminar on nuclear energy in everyday life: lectures.* Order Number DE96601738. Source: OSTI; NTIS (US Sales Only); INIS.

The so-called Nuclear Techniques used in agriculture are of two distinct types but both based on the special characteristics of radio-isotopes which give off radiation or on isotopes which are heavier than the normal element. One type of application uses the radiation given off by isotopes to enable the detection of individual atoms in infinitely small amounts of matter. With this technique we can e.g. follow the travels of fertilizer elements in the soil, into and throughout the crop plant or the travels of animal nutrient atoms throughout the animal and their deposition in milk and meat. This has resulted in enormous advances in crop and livestock research. Very minute traces of pesticides and their residues can be detected in food, in plants and animals and in the environment enabling the development of measures to reduce harmful effects.

30816 (INIS-mf–14598) **Quality characteristics of chemicals for the radioimmunoassay of thyroxine and thyrotropin.** Verdeja I, C.E. Universidad Nacional Autonoma de Mexico, Mexico City (Mexico). Facultad de Ciencias. 1994. 72p. (In Spanish). Order Number DE96602627. Source: OSTI; NTIS (US Sales Only); INIS.

Radioimmunoassay is a form of saturation analysis in which the test material competes with labelled antigen for a limited amount of antibody, the amount of label displaced being a measure of the antigen in the test sample. In this country, the kits for Radioimmunoassay (RIA) are imported, and this increase the cost of it. Because this lack of production, the National Institute of Nuclear Research (ININ) has developed RIA's kits for the thyroxine (T_4), Thyrotropin (TSH) and Triyodotironine (T_3) hormones. This work presents the conclusions of the test recommended by the WHO. The quality test were: recuperation, cross reactions, basic parameters, intra and inter assay variations, sensibility and others. The results show that the RIA's kits of the ININ have a good behavior and can be use in the clinical laboratory. (Author).

30817 (LAMP–95/4) **Detection of vegetation stress from laser-induced fluorescence signatures.** Lamp Series Report (Laser, Atomic and Molecural Physics), Lamp Series Report (Laser, Atomic and Molecural Physics). Subhash, N. International Centre for Theoretical Physics, Trieste (Italy). Jun 1995. 24p. Order Number DE96601837. Source: OSTI; NTIS (US Sales Only); INIS.

The in vivo laser-induced fluorescence (LIF) signatures of UV irradiated Salvia splendens plants were measured using an Optical Multichannel Analyser (OMA) system with Nitrogen laser excitation. The LIF spectra which consisted of the blue-green and the red chlorophyll bands were analysed with a non-linear interactive procedure using Gaussian spectral functions. The fluorescence intensity ratios of the various bands obtained from curve fitted parameters were found to be more sensitive to changes in the photosynthetic activity of the plant. The variation in the intensity ratio for the chlorophyll bands for nutrient stressed sunflower, cotton and groundnut plants as well as the nutrient and water stressed rice plants are also presented. It is observed that vegetation stress not only changes the fluorescence intensity ratios and the vitality index of the plant but also changes the peak position of the emission bands, in some cases. It is also seen that analysis of the fluorescence spectra in vegetation remote sensing applications would require a deconvolution procedure to evaluate the exact contribution of each band in the total spectra. (author). 23 refs, 8 figs, 5 tabs.

56 BIOMEDICAL SCIENCES, APPLIED STUDIES

5601 Radiation Effects

Refer also to citation(s) 28707, 28789, 28810, 28811, 28961, 29027, 29039, 29040, 29041, 29086, 29110, 29120, 29183, 29496, 30312, 30322, 30415, 30636, 30668, 30708, 30801, 30807, 31333

30818 (ARL/TR–113) **Particle sizing of airborne radioactivity field measurements at Olympic Dam.** Solomon, S.B.; Wilkis, M.; O'Brein, R.; Ganakas, G. Australian Radiation Lab., Melbourne, VIC (Australia). Dec 1993. 42p. Order Number DE96602642. Source: OSTI; NTIS; INIS.

On July 1, 1991 the Australian Radiation Laboratory (ARL) commenced a two year project entitled - Particle sizing of airborne radioactivity, funded by a Mining and Quarrying Occupational Health and Safety Committee - grant (submission No. 9138). This study was set out to measure airborne radioactivity size distributions in an underground uranium mine, in order to provide better estimates of the health risks associated with inhalation of airborne radiation in the work place. These measurements included both active and passive measurement of radon gas, continuous and spot sample of radon daughter levels, as well as wire screen diffusion

battery measurements of the radon daughter size distributions. The results of measurements at over 50 sites within the mine are reported, together with the calculated dose conversion factors derived from the older dosimetric models and from the new ICRP lung model using the computer code RADEP. The results showed that the ventilation is relatively uniform within the mine and the radon daughter concentrations are kept to less than 20% of the equilibrium concentration. The radon and radon daughter concentrations showed marked variability with both time and position within the mine. It is concluded that the present radiation protection methods and dose conversion factors used in Australia provide a good estimate of the radiation risk for the inhalation of radon progeny. 29 refs., 8 tabs., 9 figs.

30819 (ARL/TR–116) **Dose received by radiation workers in Australia, 1991.** Morris, N.D. Australian Radiation Lab., Melbourne, VIC (Australia). Jul 1994. 43p. Order Number DE96602643. Source: OSTI; NTIS; INIS.

Exposure to radiation can cause genetic defects or cancer. People who use sources of radiation as part of their employment are potentially at a greater risk than others owing to the possibility of their being continually exposed to small radiation doses over a long period. In Australia, the National Health and Medical Research Council has established radiation protection standards and set annual effective dose limits for radiation workers in order to minimise the chance of adverse effects occurring. These standards are based on the the recommendations of the International Commission on Radiological Protection (ICRP 1990). In order to ensure that the prescribed limits are not exceeded and to ensure that doses are kept to a minimum, some sort of monitoring is necessary. The primary purpose of this report is to provide data on the distribution of effective doses for different occupational categories of radiation worker in Australia. The total collective effective dose was found to be of the order of 4.9 Sv for a total of 34750 workers. 9 refs., 16 tabs., 6 figs.

30820 (CONF-9406107–7) **Dosimetric methodology of the ICRP.** Eckerman, K.F. Oak Ridge National Lab., TN (United States). [1994]. 40p. Sponsored by USDOE, Washington, DC (United States). DOE Contract AC05-84OR21400. From 1994 Health Physics Society (HPS) summer school on internal dosimetry; Davis, CA (United States); 6 Jun 1994. Order Number DE95016365. Source: OSTI; NTIS; INIS; GPO Dep.

Establishment of guidance for the protection of workers and members of the public from radiation exposures necessitates estimation of the radiation dose to tissues of the body at risk. The dosimetric methodology formulated by the International Commission on Radiological Protection (ICRP) is intended to be responsive to this need. While developed for radiation protection, elements of the methodology are often applied in addressing other radiation issues; e.g., risk assessment. This chapter provides an overview of the methodology, discusses its recent extension to age-dependent considerations, and illustrates specific aspects of the methodology through a number of numerical examples.

30821 (CONF-9508176–1) **Possible uses of animal databases for further statistical evaluation and modeling.** Griffith, W.C. (Lovelace Biomedical and Environmental Research Inst., Albuquerque, NM (United States). Inhalation Toxicology Research Inst.); Boecker, B.B.; Watson, C.R.; Gerber, G.B. Lovelace Biomedical and Environmental Research Inst., Albuquerque, NM (United States). Inhalation Toxicology Research Inst. [1995]. 4p. Sponsored by USDOE, Washington, DC (United States). DOE Contract AC04-76EV01013. From 10. international congress of radiation research; Wurzburg (Germany); 27 Aug - 1 sep 1995. Order Number DE96000325. Source: OSTI; NTIS; INIS; GPO Dep.

Many studies have been performed in animals which mimic potential exposures of people in order to understand how factors modify radiation dose-response relationships. Cooperative analyses by investigators in different laboratories have a large potential for strengthening the conclusions that can be drawn from individual studies. When information on each animal is combined, then formal tests can be made to demonstrate that apparent consistencies or inconsistencies are statistically significant. Statistical methods must be carefully chosen so that differences between laboratories or studies can be controlled or described as part of the analysis in the interpretation of the conclusions. In this report, the example of bone cancer of the large number of studies of modifying factors for bone cancer available from studies in US and European laboratories.

30822 (CONF-9508176–2) **Cancer from internal emitters.** Boecker, B.B.; Griffith, W.C. Jr. Lovelace Biomedical and Environmental Research Inst., Albuquerque, NM (United States). Inhalation Toxicology Research Inst. [1995]. 4p. Sponsored by USDOE, Washington, DC (United States). DOE Contract AC04-76EV01013. From 10. international congress of radiation research; Wurzburg (Germany); 27 Aug - 1 sep 1995. Order Number DE96000326. Source: OSTI; NTIS; INIS; GPO Dep.

Irradiation from internal emitters, or internally deposited radionuclides, is an important component of radiation exposures encountered in the workplace, home, or general environment. Long-term studies of human populations exposed to various internal emitters by different routes of exposure are producing critical information for the protection of workers and members of the general public. The purpose of this report is to examine recent developments and discuss their potential importance for understanding lifetime cancer risks from internal emitters. The major populations of persons being studied for lifetime health effects from internally deposited radionuclides are well known: Lung cancer in underground miners who inhaled Rn progeny, liver cancer from persons injected with the Th-containing radiographic contrast medium Thorotrast, bone cancer from occupational or medical intakes of ^{226}Ra or medical injections of ^{224}Ra, and thyroid cancer from exposures to iodine radionuclides in the environment or for medical purposes.

30823 (INEL–95/0185) **Idaho National Engineering Laboratory radiological control performance indicator report. Fourth quarterly calendar year 1994.** Aitken, S.B. Lockheed Idaho Technologies Co., Idaho Falls, ID (United States). Apr 1995. 22p. Sponsored by USDOE, Washington, DC (United States). DOE Contract AC07-94ID13223. Order Number DE96001340. Source: OSTI; NTIS; INIS; GPO Dep.

This document provides a report and analysis of the Radiological Control Program through the fourth quarter of calendar year 1994 (CY-1994) at the Idaho National Engineering Laboratory (INEL) under the direction of Lockheed Idaho Technologies Company (LITCO). The Radiological Performance Indicator Report is provided in accordance with Article 133 of the INEL Radiological Control Manual.

30824 (INIS-BR–3543) **Change of the natural radiation exposure due to agriculture and industrial activities in a high natural radioactivity area from Brazil.** Silva Amaral, E.C. da. Universidade Federal, Rio de Janeiro, RJ (Brazil). Inst. de Biofisica. 1992. 144p. (In Portuguese). Order Number DE96602644. Source: OSTI; NTIS; INIS.

The Pocos de Caldas Plateau, Minas Gerais State one of the biggest alkaline intrusions in the world. This study has shown the expected value for the mean annual radiation exposure due to the agricultural activities ranges from 6 up to 14 mSv/a depending on the age and living habits of the population group. The inhalation exposure of radon, thoron and their progenies represents the largest radiological health hazard (70-90%); this is followed by the external gamma irradiation from soil (10-25%). Ingestion of natural radionuclides with local food is only of minor radiological consequence. It was found that the lethal cancer risk might increase by 4% for a person born at the plateau, living and working there for the rest of her life. For the remote population the consumption the consumption of food products exported from the plateau leads to an expected value for the collective dose of 19 man Sv/a. This corresponding nominally to the small calculated number of 1 additional case of cancer per year. Therefore the main radiation impact of the agricultural activities are not the increased concentrations of natural radionuclides in food products but the fact that they are produced there with human labor and thus increasing the radiation exposure to a large number of farm workers and their families that move for occupational reasons to that region. The radiation exposure due to the mining and milling activities is, in spite of the significant increase of radionuclide activity concentrations in river waters, only of the order of 0.3 mSv/a. However as a recognized industrial source the ICRP dose limitation system has to be applied. Under

this aspect the exposure calculated here, 0.3 mSv/a, should be considered as acceptable. (author). 93 refs, 16 figs, 58 tabs.

30825 (INIS-mf–14581) **Visits by nuclear-powered warships to Australian ports. Report on radiation monitoring during 1992.** Department of Defence, Canberra, ACT (Australia). Sep 1993. 12p. Order Number DE96602646. Source: OSTI; NTIS; INIS.

Seven nuclear-powered warships (NPW) of the United States Navy visited Australian ports in 1992. The Commonwealth Government requires that a radiation monitoring program be carried out in association with each visit to detect any release of radioactivity to the ports or their environment or any increase in external radiation levels above those due to natural background radiation. Tis report presents a summary of the objectives and requirements of the NPW radiation monitoring program, describes the implementation of the program for the visit during 1992 and records the results of radiation measurements taken.

30826 (KRC–92N-S01) **Development of Skin Dose Evaluation Technology.** Song, M.J. (Korea Electric Power Corp. (KEPCO), Taejon (Korea, Republic of). Research Center); Sin, S.W.; Kim, H.G. Korea Electric Power Corp. (KEPCO), Taejon (Korea, Republic of). Research Center. 1993. 271p. (In Korean). Order Number DE96703599. Source: OSTI; NTIS (US Sales Only).

It has been known that the hot particle contaminated on skin can cause the local exposure to exceed its dose limit for skin. The main purpose of this study is to develop the technology associated to detect the skin contamination by hot particles, to improve skin dose assessment methodology, and to propose the procedures for hot particle control in order to assure the safety of the radiation workers. The study included the review of the skin structure, the possible stochastic and deterministic effects when exposed to the radiation, and the threshold dose below which such effects do not occur. The study also recommended the appropriate regulatory guider lines that help the control of the skin contamination by reviewing the recommendations stated in ICRP and the relevant regulation employed in korea currently. The physical and radiological characteristics of the hot particle were also reviewed. Finally, the hot particle detection and control procedures and the skin dose evaluation methodology were developed in this study. Therefore, by applying the methodologies or procedures developed in this study, it is believed that we can greatly improve the hot particle control, can minimize the hot particle contamination of the radiation workers and can estimate the skin dose more accurately.

30827 (NIRS-M–98, pp. 121-133) **Research subjects on internal dosimetry with emphasis on emergency.** Ishigure, Nobuhito (National Inst. of Radiological Sciences, Chiba (Japan)). National Inst. of Radiological Sciences, Chiba (Japan). Mar 1994. (In Japanese). (CONF-9312105–: 21. National Institute of Radiological Sciences, Chiba (Japan), 2-3 Dec 1993). In *Dose assessment and approach to the safety for the public in the emergency. Proceedings.* 210p. Order Number DE95747912. Source: OSTI; NTIS; INIS.

Dose assessment at emergency is essentially a methodology of presupposition both in external and internal exposures. It is, in other words, a long way to reach an appropriate estimation of dose using limited ambient information. Especially in the case of internal exposure, since the dose is determined by behaviors of radioactive materials in the environment and in the human body following intake, and also by radiation sensitivity of body tissues, we have to consider the dose assessment of internal exposure an tremendously laborious matter. In the present seminar we report three research subjects on dose assessment of internal exposure with which we are able to deal and subsequently we have to deal in near future in National Institute of Radiological Sciences. The first subject involves problems on metabolism of radioactive materials; (1) how behave the radionuclides contained within the other matrix materials and (2) how is the metabolism modified by the difference in shapes of radioactive particles. The second subject is associated with radiation sensitivity of body tissues; (1) identification of target cells and their spacial distributions in respiratory tract and (2) to obtain scientific basis to determine factors for apportionment of radiation risk among different resions of respiratory tract. As the final subject we describe variability of internal dose among populations; how can we determine variability of dosimetric parameters not to be obtained directly from human data. (author).

30828 (NIRS-M–98, pp. 134-136) **Biological dosimetry in human hematopoietic cells.** Kamada, Nanao (Hiroshima Univ. (Japan). Research Inst. for Radiation Biology and Medicine); Tanaka, Kimio. National Inst. of Radiological Sciences, Chiba (Japan). Mar 1994. (In Japanese). (CONF-9312105–: 21. National Institute of Radiological Sciences, Chiba (Japan), 2-3 Dec 1993). In *Dose assessment and approach to the safety for the public in the emergency. Proceedings.* 210p. Order Number DE95747912. Source: OSTI; NTIS; INIS.

Measurement of blood cell count is one of the most important, convenient and reliable method for estimation of exposed dose after accident. Furthermore, morphological changes in peripheral blood and bone marrow are useful for determation of therapy, like a bone marrow transplantation in cases exposed more than 5 Gy. Lymphocytes are most sensitive to radiation and the decrease of 50% of lymphocyte count is speculative for 1.5 Gy exposure to radiation. Seventy five percent of decrease of lymphocytes within 24 hours seems to be exposure to more than 3.0 Gy or more of radiation. Recently, whole chromosome painting method is available to estimate the exposure dose. Furthermore, fluorescence in situ hybridization (FISH) method of prometaphase cells gives us more precise dose estimation. Application of this method to A-bomb survivors was presented. We believe FISH method, either chromosome or prometaphase cells, will be a useful for estimation of exposed radiation in the near future. (author).

30829 (NIRS-M–98, pp. 137-151) **Dose estimation by chromosome analysis.** Hayata, Isamu (National Inst. of Radiological Sciences, Chiba (Japan)). National Inst. of Radiological Sciences, Chiba (Japan). Mar 1994. (In Japanese). (CONF-9312105–: 21. National Institute of Radiological Sciences, Chiba (Japan), 2-3 Dec 1993). In *Dose assessment and approach to the safety for the public in the emergency. Proceedings.* 210p. Order Number DE95747912. Source: OSTI; NTIS; INIS.

In this paper radiation dosimetry by chromosome analysis of peripheral lymphocytes is described as follows. (a) General features of lymphocytes (number, location, and life span). (b) Types of chromosomal aberrations used as markers in the radiation dosimetry. (c) Methods of dose estimation by means of chromosome analysis. (d) Individual difference in the yield of chromosome aberrations. (e) The dose range which can be estimated by means of chromosome analysis. (f) Chromosome aberrations caused by the environmental natural radiation. The theoretical limit of dose range to be estimated by means of the chromosome analysis is considered from about 2 rads to 800 rads in low LET radiation exposures. The lowest limit for a practical use is considered about 20 rads and analysing chromosome aberrations caused by such a dose range to obtain statistically significant data takes one technician one week laboratory work. Necessities of establishing a biodosimetry center where technicians and equipments will be stationed, and of developing the automate system for the analysis of radiation induced chromosome aberrations are also mentioned. (author).

30830 (NIRS-M–98, pp. 152-161) **Biological dosimetry by the radiation effects on the skin.** Bessho, Yuko (Tokyo Univ. (Japan). Faculty of Medicine). National Inst. of Radiological Sciences, Chiba (Japan). Mar 1994. (In Japanese). (CONF-9312105–: 21. National Institute of Radiological Sciences, Chiba (Japan), 2-3 Dec 1993). In *Dose assessment and approach to the safety for the public in the emergency. Proceedings.* 210p. Order Number DE95747912. Source: OSTI; NTIS; INIS.

In cases of partial body over-exposure, the dose estimation with personal monitors or with reconstruction of exposed conditions is often impossible without considerable error. Clinical signs of irradiated skin, such as epilation or moist desquamation have been used as the indicators of doses in the radiological accidents, because each sign has the threshold dose. As hair growth is known to be sensitive to radiation, the dose-effect relationship of the delay of hair regrowth and the reduction in hair length of mice after irradiation were examined to investigate if they can be used as biological dosimeters. Hairs on the dorsal skin of 290 ICR mice (8 weeks old) were shaved and irradiated with a Sr-90/Y-90 β-ray source in the early anagen and the midanagen stages of the hair

cycle. Skin doses were from 0.5 to 10 Gy. The time of hair regrowth and the hair length were examined with the scaling loupe. Dose-effect relationship of the delay of hair regrowth and reduction in hair length were both clearly dose dependent, fitting the L-Q or L function depending on the stage. Dose estimation functions were derived from the dose-effect relationship curves. The histological observations suggested that hair growth retardation caused by irradiation in midanagen might be due to the cell death and the depression of mitosis in the hair matrix cells. This dose estimation method was applied to the case who was over-exposed to X-ray on his hand and fingers. The findings showed that hair regrowth delay was a sensitive biological dosimeter in the case of partial body over-exposure, which could be applied as early as a few days after over-exposure. The method was simple and non-invasive to the exposed patient. (author).

30831 (ORAU–95/F-29) **Neutron quality factor.** Oak Ridge Inst. for Science and Education, TN (United States). Jun 1995. 40p. Sponsored by USDOE, Washington, DC (United States);Department of Agriculture, Washington, DC (United States);Department of Commerce, Washington, DC (United States);Department of Defense, Washington, DC (United States);Department of Health and Human Servic DOE Contract AC05-76OR00033. Order Number DE96001360. Source: OSTI; NTIS; INIS; GPO Dep.

Both the International Commission on Radiological Protection (ICRP) and the National Council on Radiation Protection and Measurements (NCRP) have recommended that the radiation quality weighting factor for neutrons (Q_n, or the corresponding new modifying factor, w_R) be increased by a value of two for most radiation protection practices. This means an increase in the recommended value for Q_n from a nominal value of 10 to a nominal value of 20. This increase may be interpreted to mean that the biological effectiveness of neutrons is two times greater than previously thought. A decision to increase the value of Q_n will have a major impact on the regulations and radiation protection programs of Federal agencies responsible for the protection of radiation workers. Therefore, the purposes of this report are: (1) to examine the general concept of "quality factor" (Q) in radiation protection and the rationale for the selection of specific values of Q_n; and (2) to make such recommendations to the Federal agencies, as appropriate. This report is not intended to be an exhaustive review of the scientific literature on the biological effects of neutrons, with the aim of defending a particular value for Q_n. Rather, the working group examined the technical issues surrounding the current recommendations of scientific advisory bodies on this matter, with the aim of determining if these recommendations should be adopted by the Federal agencies. Ultimately, the group concluded that there was no compelling basis for a change in Q_n. The report was prepared by Federal scientists working under the auspices of the Science Panel of the Committee on Interagency Radiation Research and Policy Coordination (CIRRPC).

30832 (PNL–10711) **Location analysis and strontium-90 concentrations in deer antlers on the Hanford Site.** Tiller, B.L.; Eberhardt, L.E.; Poston, T.M. Pacific Northwest Lab., Richland, WA (United States). May 1995. 60p. Sponsored by USDOE, Washington, DC (United States). DOE Contract AC06-76RL01830. Order Number DE95017602. Source: OSTI; NTIS; INIS; GPO Dep.

The primary objective of this study was to examine the levels of strontium-90 (^{90}Sr) in deer antlers collected from near previously active reactor sites and distant from the reactor sites along that portion of the Columbia River which borders the Hanford Site. A second objective was to analyze the movements and home-ranges of mule deer residing within these areas and determine to what extent this information contributes to the observed ^{90}Sr concentrations. ^{90}Sr is a long-lived radionuclide (29.1 year half life) produced by fission in irradiated fuel in plutonium production reactors on the Hanford Site. It is also a major component of atmospheric fallout from weapons testing. Concentrations of radionuclides found in the developed environment onsite do not pose a health concern to humans or various wildlife routinely monitored. However, elevated levels of radionuclides in found biota may indicate routes of exposure requiring attention.

30833 (UCRL-ID–110062-94-6) **Chernobyl Studies Project: Working group 7.0, Environmental transport and health effects. Progress report, March–September 1994.** Anspaugh, L.R.; Hendrickson, S.M. (eds.). Lawrence Livermore National Lab., CA (United States). 1 Dec 1994. 400p. Sponsored by USDOE, Washington, DC (United States). DOE Contract W-7405-ENG-48. Order Number DE95017265. Source: OSTI; NTIS; GPO Dep.

In April 1988, the US and the former-USSR signed a Memorandum of Cooperation (MOC) for Civilian Nuclear Reactor Safety; this MOC was a direct result of the accident at the Chernobyl Nuclear Power Plant Unit 4 and the following efforts by the two countries to implement a joint program to improve the safety of nuclear power plants and to understand the implications of environmental releases. A Joint Coordinating Committee for Civilian Nuclear Reactor Safety (JCCCNRS) was formed to implement the MOC. The JCCCNRS established many working groups; most of these were the responsibility of the Nuclear Regulatory Commission, as far as the US participation was concerned. The lone exception was Working Group 7 on Environmental Transport and Health Effects, for which the US participation was the responsibility of the US Department of Energy (DOE). The purpose of Working Group 7 was succintly stated to be, "To develop jointly methods to project rapidly the health effects of any future nuclear reactor accident." To implement the work DOE then formed two subworking groups: 7.1 to address Environmental Transport and 7.2 to address Health Effects. Thus, the DOE-funded Chernobyl Studies Project began. The majority of the initial tasks for this project are completed or near completion. The focus is now turned to the issue of health effects from the Chernobyl accident. Currently, we are involved in and making progress on the case-control and co-hort studies of thyroid diseases among Belarussian children. Dosimetric aspects are a fundamental part of these studies. We are currently working to implement similar studies in Ukraine. A major part of the effort of these projects is supporting these studies, both by providing methods and applications of dose reconstruction and by providing support and equipment for the medical teams.

30834 (UCRL-ID–119303) **Source terms for plutonium aerosolization from nuclear weapon accidents.** Stephens, D.R. Lawrence Livermore National Lab., CA (United States). Jul 1995. 12p. Sponsored by USDOE, Washington, DC (United States). DOE Contract W-7405-ENG-48. Order Number DE96000358. Source: OSTI; NTIS; GPO Dep.

The source term literature was reviewed to estimate aerosolized and respirable release fractions for accidents involving plutonium in high-explosive (HE) detonation and in fuel fires. For HE detonation, all estimates are based on the total amount of Pu. For fuel fires, all estimates are based on the amount of Pu oxidized. I based my estimates for HE detonation primarily upon the results from the Roller Coaster experiment. For hydrocarbon fuel fire oxidation of plutonium, I based lower bound values on laboratory experiments which represent accident scenarios with very little turbulence and updraft of a fire. Expected values for aerosolization were obtained from the Vixen A field tests, which represent a realistic case for modest turbulence and updraft, and for respirable fractions from some laboratory experiments involving large samples of Pu. Upper bound estimates for credible accidents are based on experiments involving combustion of molten plutonium droplets. In May of 1991 the DOE Pilot Safety Study Program established a group of experts to estimate the fractions of plutonium which would be aerosolized and respirable for certain nuclear weapon accident scenarios.

30835 (UCRL-JC–122072) **Reconstruction of thyroid doses for the population of Belarus following the Chernobyl accident.** Gavrilin, Y.I. (Inst. of Biophsics, Ministry of Public Health and Medical Industry SSSR, Moscow (Russian Federation)); Khrouch, V.T.; Shinkarev, S.M.; Minenko, V.F.; Drozdovich, V.V.; Ulanovsky, A.V.; Bouville, A.C.; Anspaugh, L.R.; Straume, T. Lawrence Livermore National Lab., CA (United States). Sep 1995. 4p. Sponsored by USDOE, Washington, DC (United States). DOE Contract W-7405-ENG-48. (CONF-951191–11: Conference on health consequences of the Chernobyl and other radiological accidents, Geneva (Switzerland), 20-23 Nov 1995). Order Number DE96000078. Source: OSTI; NTIS; INIS; GPO Dep.

As a sequela to the large release of ^{131}I from the accident at the Chernobyl Nuclear Power Plant, an expected late effect is thyroid cancer, especially in children. In anticipation of this problem, hundreds of thousands of measurements of thyroid glands were made with survey meters. Much attention was also focused on measuring the deposition density of ^{137}Cs. The expectation was that the latter measurement could be a good surrogate for the deposition density of ^{131}I, so that ecological models could be used to reconstruct thyroid doses in locations where no direct measurements of thyroid activity were made. However, this assumption has been seriously questioned, and there is interest in a more suitable surrogate that can still be measured even nine years or more after the accident. The purpose of this paper is to discuss the reconstruction of thyroid doses for a case-control study of childhood-thyroid cancer that has just been concluded, to discuss the reconstruction of thyroid doses for a current cohort study of childhood-thyroid cancer, and to discuss the use of ^{129}I as a surrogate for the deposition density of ^{131}I.

5603 Chemicals Metabolism and Toxicology

Refer also to citation(s) 29406, 30574, 30625, 30677, 30695, 30750

30836 (CONF-941139–3) **Indoor air and human health revisited: A recent IAQ symposium.** Gammage, R.B. Oak Ridge National Lab., TN (United States). [1994]. 6p. Sponsored by USDOE, Washington, DC (United States). DOE Contract AC05-84OR21400. From International workshop on indoor air: an integrated approach; Gold Coast (Australia); 27 Nov - 1 dec 1994. Order Number DE95016363. Source: OSTI; NTIS; GPO Dep.

Indoor Air and Human Health Revisited was a speciality symposium examining the scientific underpinnings of sensory and sensitivity effects, allergy and respiratory disease, neurotoxicity and cancer. An organizing committee selected four persons to chain the sessions and invite experts to give state-of-the-art presentations that will be published as a book. A summary of the presentations is made and some critical issues identified.

30837 (DOE/ER/60255–T1) **[Plant responses to elevated atmospheric carbon dioxide and transmission to other trophic levels]. Final report.** Lincoln, D.E. South Carolina Univ., Columbia, SC (United States). Dept. of Biological Sciences. [1995]. 5p. Sponsored by USDOE, Washington, DC (United States). DOE Contract FG09-84ER60255. Order Number DE96000297. Source: OSTI; NTIS; GPO Dep.

This program investigated how host plant responses to elevated atmospheric carbon dioxide may be transmitted to other trophic levels, especially leaf eating insects, and alter consumption of leaves and impare their function. Study results included the following findings: increased carbon dioxide to plants alters feeding by insect herbivores; leaves produced under higher carbon conditions contain proportionally less nitrogen; insect herbivores may have decreased reproduction under elevated carbon dioxide.

30838 (DOE/ER/60255–T2) **[Plant responses to elevated atmospheric carbon dioxide and transmission to other trophic levels]. Progress report, May 1991, DOE Grant DE-FG09-84ER60255.** Lincoln, D.E. South Carolina Univ., Columbia, SC (United States). Dept. of Biological Sciences. May 1991. 6p. Sponsored by USDOE, Washington, DC (United States). DOE Contract FG09-84ER60255. Order Number DE96000920. Source: OSTI; NTIS; GPO Dep.

Experiments were performed to determine the effects of carbon dioxide on plants and on the insects feeding on these plants. Current progress is reported for the following experiments: Response of a Specialist-Feeding Insect Herbivore to Carbon Dioxide Induced Changes in Its Hostplant; Growth and Reproduction of Grasshoppers Feeding on a C_4 Grass Under Elevated Carbon Dioxide; Elevated Carbon Dioxide and Temperature Effects on Growth and Defense of Big Sagebrush; Sagebrush and Grasshopper Responses to Atmospheric Carbon Dioxide Concentration; Biomass Allocation Patterns of Defoliated Sagebrush Grown Under Two Levels of Carbon Dioxide; and Sagebrush Carbon Allocation Patterns and Grasshopper Nutrition: The Influence of Carbon Dioxide Enrichment and Soil Mineral Limitation.

30839 (LA–13019-MS) **Aquatic invertebrate sampling at selected outfalls in Operable Unit 1082; Technical areas 9, 11, 16 and 22.** Cross, S. Los Alamos National Lab., NM (United States). Sep 1995. 57p. Sponsored by USDOE, Washington, DC (United States). DOE Contract W-7405-ENG-36. Order Number DE96000890. Source: OSTI; NTIS; GPO Dep.

The Ecological Studies Team (EST) of ESH-20 at Los Alamos National Laboratory conducted preliminary aquatic sampling at outfalls within Operable Unit 1082 and nearby natural waterways. Eleven outfalls were sampled a total of eighteen times. Three natural waterways (upper Pajarito Canyon, Starmer's Gulch, and Bulldog Spring) in the vicinity were sampled a total of six times. At most sites, EST recorded hydrological condition, physico-chemical parameters, wildlife uses, and vegetation. At each outfall with water and each natural waterway, EST collected an aquatic invertebrate sample which was analyzed by taxa composition, Wilhm's biodiversity index, the community tolerance quotient (CTQ), and density. The physico-chemical parameters at most outfalls and natural waterways fell within the normal range of natural waters in the area. However, the outfalls are characterized by low biodiversity and severely stressed communities composed of a restricted number of taxa. The habitat at the other outfalls could probably support well-developed aquatic communities if sufficient water was available. At present, the hydrology at these outfalls is too slight and/or sporadic to support such a community in the foreseeable future. In contrast to the outfalls, the natural waterways of the area had greater densities of aquatic invertebrates, higher biodiversities, and lower CTQs.

30840 (PNL–8077) **Effects of cooking on levels of PCBs in the fillets of winter flounder (Pseudopleureonectes americanus).** Poston, T.M. (Pacific Northwest Lab., Richland, WA (United States)); Durell, G.S.; Koczwara, G.; Spellacy, A.M. Pacific Northwest Lab., Richland, WA (United States). Aug 1995. 70p. Sponsored by USDOE, Washington, DC (United States). DOE Contract AC06-76RL01830. Order Number DE95017589. Source: OSTI; NTIS; GPO Dep.

The Pacific Northwest Laboratory and Battelle Ocean Sciences performed a study to determine the effect of cooking on polychlorinated biphenyl (PCB) levels in the fillets of winter flounder (Pseudopleuronectes americanus). Broiling, pan frying, and deep frying in oil were tested on fillets from 21 fish collected from New Bedford Harbor, Massachusetts, on February 21, 1991. The evaluation involved estimating the change in PCB concentrations using a mass-balance approach that factored the change in fillet weight resulting from cooking with the changes in PCB concentration expressed on a precooked wet-weight basis. Deep frying in oil resulted in a 47% reduction in total PCB levels in fillet tissue. Additionally, deep frying caused a 40% reduction in fillet mass. Pan frying and broiling resulted in statistically in insignificant increases in total PCB levels of 15% and 17%, respectively. Fillet mass reductions resulting from pan frying and broiling were 7% and 15%, respectively. The effects of cooking on 18 individual congeners generally paralleled the results observed for total PCB. All 18 congeners were significantly reduced by deep frying. Congener $Cl_2(08)$ also was significantly reduced by either pan frying. Congeners $Cl_5(105)$ and $Cl_5(118)$ showed apparent significant increases in concentrations following pan frying. Congeners $Cl_5(105)$, $Cl_5(118)$, and $C1_6(138)$ showed significant increases in concentration following broiling.

30841 (UCRL-ID–119708) **New perspectives on the cancer risks of trichloroethylene, its metabolites, and chlorination by-products.** Bogen, K.T. (Lawrence Livermore National Lab., CA (United States)); Slone, T.; Gold, L.S.; Manley, N.; Revzan, K. Lawrence Livermore National Lab., CA (United States); Lawrence Berkeley Lab., CA (United States). 8 Dec 1994. 66p. Sponsored by USDOE, Washington, DC (United States). DOE Contract W-7405-ENG-48 ; AC03-76SF00098. Order Number DE96000368. Source: OSTI; NTIS; GPO Dep.

Scientific developments in the 1990's have important implications for the assessment of cancer risks posed by exposures to trichloroethylene (TCE). These new developments include: epidemiological studies; experimental studies of TCE carcinogenicity, metabolism and metabolite carcinogenicity; applications of new physiologically based pharmacokinetic (PBPK) models for TCE;

and new pharmacodynamic data obtained for TCE and its rhetabolites. Following a review of previous assessments of TCE carcinogenicity, each of these new sets of developments is summarized. The new epidemiological data do not provide evidence of TCE carcinogenicity in humans, and the new pharmacodynamic data support the hypothesis that TCE carcinogenicity is caused by TCE-induced cytotoxicity. Based on this information, PBPK-based estimates for likely no-adverse effect levels (NOAELs) for human exposures to TCE are calculated to be 16 ppb for TCE in air respired 24 hr/day, and 210 ppb for TCE in drinking water. Cancer risks of zero are predicted for TCE exposures below these calculated NOAELs. For comparison, hypothetical cancer risks posed by lifetime ingestive and multiroute household exposures to TCE in drinking water, at the currently enforced Maximum Contaminant Level (MCL) concentration of 5 ppb are extrapolated from animal bioassay data using a conservative, linear dose-response model. These TCE-related risks are compared to corresponding ones associated with concentrations of chlorination by-products (CBP) in household water. It is shown that, from the standpoint of comparative hypothetical cancer risks, based on conservative linear dose-response extrapolations, there would likely be no health benefit, and more likely a possible health detriment, associated with any switch from a household water supply containing <375 ppb TCE to one containing CBP at levels corresponding to the currently proposed 80-ppb MCL for total trihalomethanes.

5604 Other Environmental Pollutant Effects

30842 (DOE/GO–10095-014) **Electric and magnetic fields program overview.** National Renewable Energy Lab., Golden, CO (United States). Sep 1995. 12p. Sponsored by USDOE, Washington, DC (United States). DOE Contract AC36-83CH10093. Order Number DE95000206. Source: OSTI; NTIS; GPO Dep.

DOE's EMF Program is presented. The possibility of biological effects from electromagnetic fields created by electricity is examined. Current research at many National Laboratories is reviewed.

57 HEALTH AND SAFETY

Refer also to citation(s) 30625, 30834, 31317

30843 (EGG–11265-1124) **After-action summary for handshake one.** Hopkins, R.C. EG and G Energy Measurements, Inc., Las Vegas, NV (United States). [1995]. 4p. Sponsored by USDOE, Washington, DC (United States). DOE Contract AC08-93NV11265. (CONF-950430–10: 5. ANS topical meeting on emergency preparedness and response, Savannah, GA (United States), 18-21 Apr 1995). Order Number DE96000158. Source: OSTI; NTIS; GPO Dep.

The Federal Radiological Monitoring and Assessment Center (FRMAC) conducted a three day training drill May 17 through May 19, 1994 at the Nevada Test Site (NTS). The drill was designed to provide training to field monitors and data assessors who would respond to a major radiological emergency. The drill was named "HANDSHAKE ONE" to symbolize the strong FRMAC relationship between the federal and state radiological agencies.

5701 Real Accidents

Refer also to citation(s) 29458

58 GEOSCIENCES

Refer also to citation(s) 28735, 28809, 28891, 28892, 28900, 28918, 28964, 28965, 28966, 29010, 29011, 29012, 29034, 29046, 29115, 30354, 30357, 30619, 30638, 30686, 30688, 30689, 30690, 30691, 30692, 30693, 30700, 30702, 30718, 30719, 30754, 31323, 31324, 31355

30844 (ANL/MCS/CP–85860) **Parallel implementation, validation, and performance of MM5.** Michalakes, J. (Argonne National Lab., IL (United States)); Canfield, T.; Nanjundiah, R.; Hammond, S.; Grell, G. Argonne National Lab., IL (United States). [1994]. 12p. Sponsored by USDOE, Washington, DC (United States). DOE Contract W-31-109-ENG-38. (CONF-9411178–3: 6. workshop on use of parallel processors in meterology, Reading (United Kingdom), 24 Nov 1994). Order Number DE95012399. Source: OSTI; NTIS; GPO Dep.

We describe a parallel implementation of the nonhydrostatic version of the Penn State/NCAR Mesoscale Model, MM5, that includes nesting capabilities. This version of the model can run on many different massively Parallel computers (including a cluster of workstations). The model has been implemented and run on the IBM SP and Intel multiprocessors using a columnwise decomposition that supports irregularly shaped allocations of the problem to processors. This stategy will facilitate dynamic load balancing for improved parallel efficiency and promotes a modular design that simplifies the nesting problem AU data communication for finite differencing, inter-domain exchange of data, and I/O is encapsulated within a parallel library, RSL. Hence, there are no sends or receives in the parallel model itself. The library is Generalizable to other, similar finite difference approximation codes. The code is validated by comparing the rate of growth in error between the sequential and parallel models with the error growth rate when the sequential model input is perturbed to simulate floating point rounding error. Series of runs on increasing numbers of parallel processors demonstrate that the parallel implementation is efficient and scalable to large numbers of processors.

30845 (BNL–61964) **Sulfur transformations in early diagenetic sediments from the Bay of Concepcion, off Chile.** Vairavamurth, M.A. (Brookhaven National Lab., Upton, NY (United States)); Wang, Shengke; Khandelwal, B.; Manowitz, B.; Ferdelman, T.; Fossing, H. Brookhaven National Lab., Upton, NY (United States). Apr 1995. 24p. Sponsored by USDOE, Washington, DC (United States). DOE Contract AC02-76CH00016. Order Number DE95016018. Source: OSTI; NTIS; GPO Dep.

Despite the recognition that both organic sulfur and pyrite form during the very early stages of diagenesis, and that the amount of H_2S generated in bacterial sulfate reduction primarily limits their formation, the mechanisms and the active species involved still are not clear. In this study, we quantified the major forms of sulfur distributed in sediments to assess the geochemical mechanisms involved in these transformations. XANES spectroscopy, together with elemental analysis, were used to measure sulfur speciation in the organic-rich sediments from the Bay of Concepcion, Chile. Organic polysulfides constituted the major fraction of the organic sulfur, and occurred maximally just below the sediment surface (1–3 cm), where intermediates from H_2S oxidation were likely to be generated most abundantly. Sulfonates, which could be formed through the reactions of sulfate and thiosulfate, also showed a subsurface maximum in the vicinity of the "oxic-anoxic interface". These results strongly suggest a geochemical origin for organic polysulfides and sulfonates, and illustrate that intermediates from H_2S oxidation play a dominant role in incorporating sulfur into organic matter. Pyrite was absent in the surficial layer, and first appeared just below the H_2S maximum, where organic polysulfides began to decrease in abundance. From these results, we argue, that an iron monosulfide precursor formed first from reactions with H_2S, and then reacts with organic polysulfides, completing the synthesis of pyrite in the sediment column.

30846 (EGG–11265-5032) **Final report on repair procedure of strong ground motion data from underground nuclear tests.** Tunnell, T.W. EG and G Energy Measurements, Inc., Los Alamos, NM (United States). Los Alamos Operations. Apr 1995. 65p. Sponsored by USDOE, Washington, DC (United States). DOE Contract AC08-93NV11265. Order Number DE96001097. Source: OSTI; NTIS; GPO Dep.

Certain difficulties arise when recording close-in around motion from underground nuclear explosions. Data quality can be compromised by a variety of factors, including electromagnetic pulse, noise spikes, direct current effect, and gauge clipping and gauge tilt. From March 1988 through September 1994, EG&G Energy Measurements repaired strong round-motion data (acceleration data) from underground nuclear tests for the Los Alamos National Laboratory using, an automated repair procedure. The automated repair determined and implemented the required repairs based on

user input and a consistent set of criteria. A log was kept of each repair so that the repair procedure could be duplicated. This relaxed the requirement to save the repaired data. Developed for the VAX system, the procedure allowed the user to stack up a large number of repairs, plot the repaired data, and obtain hard copies. The plotted data could then be reviewed for a given test to determine the consistency of repair for a given underground test. This feature released the user to perform other tasks while the data were being repaired.

30847 (IC–95/116) **Tangshan 1976 earthquake: Modelling of the SH-wave motion in the area of Xiji-Langfu.** Sun, R. (Science Academy of China, Beijing (China). Inst. of Geophysics); Vaccari, F.; Marrara, F.; Panza, G.F. International Centre for Theoretical Physics, Trieste (Italy). Jun 1995. 37p. Order Number DE96602585. Source: OSTI; NTIS (US Sales Only); INIS.

The reasons for the anomalous high macroseismic intensity caused in the Xiji-Langfu area by the Tangshan, 1976 earthquake can be found in its special geological conditions. This area is formed of deep deposits beside the Xiadian fault, that consist mainly of alluvium sands and clays, which are poorly consolidated with high water content. Resonances, excitation of local surface waves and their propagation cause strong amplifications and long durations of signals. Based on simulated strong ground motion, we have computed quantities commonly used for engineering purposes: the maximum amplitude (AMAX) and the total energy of ground motion (W), which is related to the Arias Intensity. AMAX and W do not decrease gradually as the epicentral distance increases, since the low velocities and the thickness of the deposits are responsible for the large increment of the values of AMAX and W inside the basin. On the two sides of the Xiadian fault AMAX and W can vary by 200% and 700% respectively. This computational result can be used to explain the large macroseismic intensity observed in the Xiji-Langfu area, in connection with the Tangshan earthquake. The spectral ratios show that over the whole area significant amplifications occur in the range of frequencies from 0.3 Hz to 1.5 Hz, while the largest amplification is above 6 and takes place around 3 Hz at a distance of about 112 km. from the epicentre. (author). 18 refs, 15 figs, 2 tabs.

30848 (IC–95/147) **Seismotectonic models and CN algorithm: The case of Italy.** Costa, G. (International Centre for Theoretical Physics, Trieste (Italy)); Orozova Stanishkova, I.; Panza, G.F.; Rotwain, I.M. International Centre for Theoretical Physics, Trieste (Italy). Jul 1995. 19p. Order Number DE96602586. Source: OSTI; NTIS (US Sales Only); INIS.

The CN algorithm is here utilized both for the intermediate term earthquake prediction and to validate the seismotectonic model of the Italian territory. Using the results of the analysis, made through the CN algorithm and taking into account the seismotectonic model, three areas, one for Northern Italy, one for Central Italy and one for Southern Italy, are defined. Two transition areas, between the three main areas are delineated. The earthquakes which occurred in these two areas contribute to the precursor phenomena identified by the CN algorithm in each main area. (author). 26 refs, 6 figs, 2 tabs.

30849 (LA-UR–95-1659) **Wavelet subband coding of computer simulation output using the A++ array class library.** Bradley, J.N. (Los Alamos National Lab., NM (United States)); Brislawn, C.M.; Quinlan, D.J.; Zhang, H.D.; Nuri, V. Los Alamos National Lab., NM (United States). [1995]. 16p. Sponsored by USDOE, Washington, DC (United States). DOE Contract W-7405-ENG-36. (CONF-9503181–1: NASA space and earth science data compression workshop, Salt Lake City, UT (United States), 27 Mar 1995). Order Number DE95015332. Source: OSTI; NTIS; GPO Dep.

The goal of the project is to produce utility software for off-line compression of existing data and library code that can be called from a simulation program for on-line compression of data dumps as the simulation proceeds. Naturally, we would like the amount of CPU time required by the compression algorithm to be small in comparison to the requirements of typical simulation codes. We also want the algorithm to accomodate a wide variety of smooth, multidimensional data types. For these reasons, the subband vector quantization (VQ) approach employed in has been replaced by a scalar quantization (SQ) strategy using a bank of almost-uniform scalar subband quantizers in a scheme similar to that used in the FBI fingerprint image compression standard. This eliminates the considerable computational burdens of training VQ codebooks for each new type of data and performing nearest-vector searches to encode the data. The comparison of subband VQ and SQ algorithms in indicated that, in practice, there is relatively little additional gain from using vector as opposed to scalar quantization on DWT subbands, even when the source imagery is from a very homogeneous population, and our subjective experience with synthetic computer-generated data supports this stance. It appears that a careful study is needed of the tradeoffs involved in selecting scalar vs. vector subband quantization, but such an analysis is beyond the scope of this paper. Our present work is focused on the problem of generating wavelet transform/scalar quantization (WSQ) implementations that can be ported easily between different hardware environments. This is an extremely important consideration given the great profusion of different high-performance computing architectures available, the high cost associated with learning how to map algorithms effectively onto a new architecture, and the rapid rate of evolution in the world of high-performance computing.

30850 (LBL–37356) **Preliminary development of the LBL/USGS three-dimensional site-scale model of Yucca Mountain, Nevada.** Wittwer, C. (Bureau de Recherches Geologiques et Minieres (BRGM), 45 - Orleans (France). Dept. Geothermie et Hydroenergie); Chen, G.; Bodvarsson, G.S.; Chornack, M.; Flint, A.; Flint, L.; Kwicklis, E.; Spengler, R. Lawrence Berkeley Lab., CA (United States). Jun 1995. 100p. Sponsored by USDOE, Washington, DC (United States). DOE Contract AC03-76SF00098 ; AI08-78ET44802. Order Number DE96000149. Source: OSTI; NTIS; INIS; GPO Dep.

A 3-D model of moisture flow within the unsaturated zone at Yucca Mountain is being developed at LBL in cooperation with USGS. This site-scale model covers an area of about 34 km^2 and is bounded by major faults to the north, east, and west. The relatively coarse-grid model includes about 300 horizontal grid-blocks and 17 layers. Contour maps and isopach maps are presented defining different types of infiltration zones, and the spatial distribution of Tiva Canyon, Paintbrush, and Topopah Spring hydrogeological units. Matrix flow is approximated using the van Genuchten model, and the equivalent continuum approximation is used to account for fracture flow in the welded units. One-, two-, and three-dimensional simulations are conducted using the TOUGH2 computer program. Steady-state simulations are performed with various uniform and nonuniform infiltration rates; results are interpreted in terms of effect of fault characteristics on moisture flow distribution, and on the location and formation of preferential pathways.

30851 (SAND–94-2384) **Frictional sliding in layered rock model: Preliminary experiments. Yucca Mountain Site Characterization Project.** Perry, K.E. Jr. (Idaho National Engineering Lab., Idaho Falls, ID (United States)); Buescher, B.J.; Anderson, D.; Epstein, J.S. Sandia National Labs., Albuquerque, NM (United States). Sep 1995. 15p. Sponsored by USDOE, Washington, DC (United States). DOE Contract AC04-94AL85000. Order Number DE96000205. Source: OSTI; NTIS; INIS; GPO Dep.

An important aspect of determining the suitability of Yucca Mountain as a possible nuclear waste repository requires understanding the mechanical behavior of jointed rock-masses. To this end we have studied the frictional sliding between simulated rock joints in the laboratory using the technique of phase shifting moire interferometry. The models were made from stacks of Lexan plates and contained a central hole to induce slip between the plates when the models were loaded in compression. These preliminary results confirm the feasibility of the approach and show a clear evolution of slip as function of load.

30852 (UCRL-JC–118923) **Propagation of seismic waves in irregularly layered media using boundary integral equations.** Schultz, C.A.; Bouchon, M. Lawrence Livermore National Lab., CA (United States). Dec 1994. 14p. Sponsored by USDOE, Washington, DC (United States). DOE Contract W-7405-ENG-48. (CONF-941280–1: American Geophysical Union fall meeting, San Francisco, CA (United States), 5 Dec 1994). Order Number DE95015992. Source: OSTI; NTIS; GPO Dep.

This document begins with the derivation of the linear equations system based on Green functions. Next, the resolution limits of the system are described. Then, an example calculation is given, along with graphical representations of the results.

30853 (UCRL-JC–119218) **Neural networks in seismic discrimination.** Dowla, F.U. Lawrence Livermore National Lab., CA (United States). Jan 1995. 15p. Sponsored by USDOE, Washington, DC (United States). DOE Contract W-7405-ENG-48. (CONF-950151–7: NATO (ASI)/monitoring a comprehensive test ban treaty, Algrave (Portugal), 23 Jan - 2 feb 1995). Order Number DE95015894. Source: OSTI; NTIS; GPO Dep.

Neural networks are powerful and elegant computational tools that can be used in the analysis of geophysical signals. At Lawrence Livermore National Laboratory, we have developed neural networks to solve problems in seismic discrimination, event classification, and seismic and hydrodynamic yield estimation. Other researchers have used neural networks for seismic phase identification. We are currently developing neural networks to estimate depths of seismic events using regional seismograms. In this paper different types of network architecture and representation techniques are discussed. We address the important problem of designing neural networks with good generalization capabilities. Examples of neural networks for treaty verification applications are also described.

30854 (UCRL-JC–121747) **Automated Data Processing (ADP) research and development.** Dowla, F.U.; Kohlhepp, V.N.; Leach, R.R. Jr. Lawrence Livermore National Lab., CA (United States). Jul 1995. 10p. Sponsored by USDOE, Washington, DC (United States). DOE Contract W-7405-ENG-48. (CONF-950921–8: 16. international conference on amorphous semiconductors, Kobe (Japan), 4-8 Sep 1995). Order Number DE95016592. Source: OSTI; NTIS; GPO Dep.

Monitoring a comprehensive test ban treaty (CTBT) will require screening tens of thousands of seismic events each year. Reliable automated data analysis will be essential in keeping up with the continuous stream of events that a global monitoring network will detect. We are developing automated event location and identification algorithms by looking at the gaps and weaknesses in conventional ADP systems and by taking advantage of modern computational paradigms. Our research focus is on three areas: developing robust algorithms for signal feature extraction, integrating the analysis of critical measurements, and exploiting joint estimation techniques such as using data from acoustic, hydroacoustic, and seismic sensors. We identify several important problems for research and development; e.g., event location with approximate velocity models and event identification in the presence of outliers. We are employing both linear and nonlinear methods and advanced signal transform techniques to solve these event monitoring problems. Our goal is to increase event-interpretation throughput by employing the power and efficiency of modern computational techniques, and to improve the reliability of automated analysis by reducing the rates of false alarms and missed detections.

66 PHYSICS

6611 Classical and Quantum Mechanics

Refer also to citation(s) 30903, 30923, 30925

30855 (IC–95/101) **On some representations of current algebras in two dimensions and their central extensions.** Donkov, S. (Sofia Univ., Sofia (Bulgaria). Dept. of Physics); Stoytchev, O. International Centre for Theoretical Physics, Trieste (Italy). Jun 1995. 17p. Order Number DE96602150. Source: OSTI; NTIS (US Sales Only); INIS.

We consider a class of unitary representations of the group of maps from a Riemannian manifold to a compact semisimple Lie group which are a modification of the so called energy representations. We prove irreducibility for them in any dimension ≥ 2. This extends the known results of irreducibility for certain cases in dimension 2. Next, we consider the corresponding algebra representations. Their irreducibility in dimension 2 is also proved. These are extended in a natural way to representations of certain central extensions of the algebras. We give very explicit formulae, particularly on the two-dimensional torus, for the algebra extensions and the representations. (author). 9 refs.

30856 (IC–95/107) **Exact solutions to the Langevin equations for systems with second class constraints.** Baleanu, D. International Centre for Theoretical Physics, Trieste (Italy). Jun 1995. 8p. Order Number DE96602151. Source: OSTI; NTIS (US Sales Only); INIS.

Using the phase space stochastic quantization scheme the quantization of the system with the second class constraints are investigated. (author). 13 refs.

30857 (IC–95/127) **Algebraic description of one-dimensional potentials and the su(1,1) Lie algebra.** Ionescu, R.A. (International Centre for Theoretical Physics, Trieste (Italy)); Ludu, A.; Scheid, W. International Centre for Theoretical Physics, Trieste (Italy). Jun 1995. 13p. Order Number DE96602152. Source: OSTI; NTIS (US Sales Only); INIS.

The eigenstates of a particle in a rectangular-well potential with appropriate boundary conditions are proved to be the standard basis of an irreducible representation of the su(1,1) Lie algebra. The algebra operators are constructed explicitly. Other potentials can be related to the su(1,1) Lie algebra in this framework. This algebraic approach allows us to write an algebraic parametrization for the R-function. (author). 15 refs.

30858 (IC–95/129) **On differential realizations of the so(1,2) Lie algebra and one-dimensional geometric potentials.** Ionescu, R.A. International Centre for Theoretical Physics, Trieste (Italy). Jun 1995. 11p. Order Number DE96602153. Source: OSTI; NTIS (US Sales Only); INIS.

We obtain the so(1,2) Lie algebra operator as second-order differential operators in two variables. We prove that a particular realization in terms of first-order differential operators is related to a class of one-dimensional potentials which includes the Morse and Poeschl-Teller potentials. Also, we obtain a new second-order differential realization. (author). 9 refs.

30859 (INIS-BR–3540, pp. 66-70) **Gauge and integrability in linear and non-linear equations.** Souza, M.M. de (Espirito Santo Univ., Vitoria, ES (Brazil). Dept. de Fisica e Quimica). Sociedade Brasileira de Fisica, Sao Paulo, SP (Brazil). 1993. 251p. (In Portuguese). (CONF-9109557–: 12. national meeting on particle physics and fields, Caxambu (Brazil), 18-22 Sep 1991). In *Proceedings of the 12. National Meeting on Particle Physics and Fields.* Order Number DE96602594. Source: OSTI; NTIS; INIS.

Permutational symmetries for constructing decision algorithm on the integrability of equation system are used. Gauge structures of Maxwell and Einstein equations are compared using as example linear and non linear systems respectively. (M.C.K.).

30860 (INIS-BR–3540, pp. 192-195) **Coherent states of 3 D radial oscillator.** Rodrigues, R.L. (Paraiba Univ., Cajazeiras, PB (Brazil). Dept. de Ciencias Exatas e da Natureza); Vaidya, A.N.; Jayaraman, J. Sociedade Brasileira de Fisica, Sao Paulo, SP (Brazil). 1993. 251p. (In Portuguese). (CONF-9109557–: 12. national meeting on particle physics and fields, Caxambu (Brazil), 18-22 Sep 1991). In *Proceedings of the 12. National Meeting on Particle Physics and Fields.* Order Number DE96602594. Source: OSTI; NTIS; INIS.

The canonical and generalized coherent states of 3 D radial oscillator are obtained by operators derived form super-realization of Wigner-Heisenberg algebra. Coherent states of S L(2,R) Perelomov group were used to obtain oscillator spectrum. (M.C.K.). 10 refs.

30861 (INIS-BR–3540, pp. 222-225) **Coherent states of 3 D isotropic harmonic oscillator with spin 1/2.** Rodrigues, R.L. (Paraiba Univ., Cajazeiras, PB (Brazil). Dept. de Ciencias Exatas e da Natureza); Vaidya, A.N.; Jayaraman, J. Sociedade Brasileira de Fisica, Sao Paulo, SP (Brazil). 1993. 251p. (In Portuguese). (CONF-9109557–: 12. national meeting on particle physics and fields, Caxambu (Brazil), 18-22 Sep 1991). In *Proceedings of the 12. National Meeting on Particle Physics and Fields.* Order Number DE96602594. Source: OSTI; NTIS; INIS.

The spherical coherent states are built via Wigner-Heisenberg algebra of three degrees of freedom. They are the eigenstates of the spherical annihilation operator of 3 D isotropic harmonic oscillator with spin 1/2. (M.C.K.). 6 refs.

30862 (LBL–37315) **Values and the quantum conception of man.** Stapp, H.P. Lawrence Berkeley Lab., CA (United States). Jun 1995. 10p. Sponsored by USDOE, Washington, DC (United States). DOE Contract AC03-76SF00098. (CONF-9509223–1: UNESCO symposium on science and culture: common path for the future, Tokyo (Japan), 10-15 Sep 1995). Order Number DE96000121. Source: OSTI; NTIS; GPO Dep.

Classical mechanics is based upon a mechanical picture of nature that is fundamentally incorrect. It has been replaced at the basic level by a radically different theory: quantum mechanics. This change entails an enormous shift in one's basic conception of nature, one that can profoundly alter the scientific image of man himself. Self-image is the foundation of values, and the replacement of the mechanistic self-image derived from classical mechanics by one concordant with quantum mechanics may provide the foundation of a moral order better suited to today's times, a self-image that endows human life with meaning, responsibility, and a deeper linkage to nature as a whole.

30863 (SAND–95-8488) **Metastable states and intermittent switching of small populations of confined point vortices.** Schmieder, R.W. Sandia National Labs., Livermore, CA (United States). Jul 1995. 29p. Sponsored by USDOE, Washington, DC (United States). DOE Contract AC04-94AL85000. Order Number DE95017522. Source: OSTI; NTIS; GPO Dep.

We have found that small populations of point vortices confined in a box exhibit a variety of new and interesting metastable collective motions, ranging from rigid body rotation to complete chaos. These motions are induced by simulated heating and cooling of the vortices; they do not appear in adiabatic systems. By judicious choice of vortex circulations, heating and cooling rates, and box size, we have produced systems that switch intermittently between several metastable states, that oscillate quasi-periodically, and that show a variety of interesting collective behaviors that in some cases are suggestive of biological organisms.

30864 (SLAC-PUB–95-6760) **On the Lorentz invariance of bit-string geometry.** Noyes, H.P. Stanford Univ., CA (United States). Sep 1995. 15p. Sponsored by USDOE, Washington, DC (United States). DOE Contract AC03-76SF00515. (CONF-9502121–1: 11. annual meeting of the Western Chapter of the Alternative Natural Philosophy Association, Stanford, CA (United States), 18-20 Feb 1995). Order Number DE96001000. Source: OSTI; NTIS; INIS; GPO Dep.

We construct the class of integer-sided triangles and tetrahedra that respectively correspond to two or three discriminately independent bit-strings. In order to specify integer coordinates in this space, we take one vertex of a regular tetrahedron whose common edge length is an even integer as the origin of a line of integer length to the "point" and three integer distances to this "point" from the three remaining vertices of the reference tetrahedron. This - usually chiral - integer coordinate description of bit-string geometry is possible because three discriminately independent bit-strings generate four more; the Hamming measures of these seven strings always allow this geometrical interpretation. On another occasion we intend to prove the rotational invariance of this coordinate description. By identifying the corners of these figures with the positions of recording counters whose clocks are synchronized using the Einstein convention, we define velocities in this space. This suggests that it may be possible to define boosts and discrete Lorentz transformations in a space of integer coordinates. We relate this description to our previous work on measurement accuracy and the discrete ordered calculus of Etter and Kauffman (DOC).

30865 (UCRL-JC–122100) **Microscopic time-reversibility and macroscopic irreversibility: Still a paradox.** Posch, H.A. (Universitaet Wien (Austria). Inst. fuer Experimentalphysik); Dellago, Ch.; Hoover, W.G.; Kum, O. Lawrence Livermore National Lab., CA (United States). 13 Sep 1995. 20p. Sponsored by USDOE, Washington, DC (United States);Government of the Republic of Korea, Seoul (Korea, Republic of). DOE Contract W-7405-ENG-48. Grant P09677. (CONF-9506268–1: University of Vienna symposium, Vienna (Austria), 25-28 Jun 1995). Order Number DE96000391. Source: OSTI; NTIS; GPO Dep.

Microscopic time reversibility and macroscopic irreversibility are a paradoxical combination. This was first observed by J. Loschmidt in 1876 and was explained, for conservative systems, by L. Boltzmann the following year. Both these features are also present in modern simulations of classic many-body systems in steady nonequilibrium states. We illustrate them here for the simplest possible models, a continuous one-dimensional model of field-driven diffusion, the so-called driven Lorentz gas or Galton Board, and an ergodic time reversible dissipative map.

30866 (UCRL-LR–121751) **Nonequilibrium flows with smooth particle applied mechanics.** Kum, O. Lawrence Livermore National Lab., CA (United States). Jul 1995. 199p. Sponsored by USDOE, Washington, DC (United States). DOE Contract W-7405-ENG-48. Order Number DE95017266. Source: OSTI; NTIS; GPO Dep.

Thesis submitted by Oyeon Kum to University of California, Davis.

Smooth particle methods are relatively new methods for simulating solid and fluid flows through they have a 20-year history of solving complex hydrodynamic problems in astrophysics, such as colliding planets and stars, for which correct answers are unknown. The results presented in this thesis evaluate the adaptability or fitness of the method for typical hydrocode production problems. For finite hydrodynamic systems, boundary conditions are important. A reflective boundary condition with image particles is a good way to prevent a density anomaly at the boundary and to keep the fluxes continuous there. Boundary values of temperature and velocity can be separately controlled. The gradient algorithm, based on differentiating the smooth particle expression for $(u\rho)$ and $(T\rho)$, does not show numerical instabilities for the stress tensor and heat flux vector quantities which require second derivatives in space when Fourier's heat-flow law and Newton's viscous force law are used. Smooth particle methods show an interesting parallel linking to them to molecular dynamics. For the inviscid Euler equation, with an isentropic ideal gas equation of state, the smooth particle algorithm generates trajectories isomorphic to those generated by molecular dynamics. The shear moduli were evaluated based on molecular dynamics calculations for the three weighting functions, B spline, Lucy, and Cusp functions. The accuracy and applicability of the methods were estimated by comparing a set of smooth particle Rayleigh-Benard problems, all in the laminar regime, to corresponding highly-accurate grid-based numerical solutions of continuum equations. Both transient and stationary smooth particle solutions reproduce the grid-based data with velocity errors on the order of 5%. The smooth particle method still provides robust solutions at high Rayleigh number where grid-based methods fails.

30867 (UM-P–95/24) **The quest for quantum gravity.** Au, G. Melbourne Univ., Parkville, VIC (Australia). School of Physics. Mar 1995. 18p. Order Number DE96602803. Source: OSTI; NTIS; INIS.

This presentation is based on interviews with Chris Isham, Ed Witten and Abhay Ashekar.

One of the greatest challenges facing theoretical physics lies in reconciling Einstein's classical theory of gravity - general relativity -with quantum field theory. Although both theories have been experimentally supported in their respective regimes, they are as compatible as a square peg and a round hole. This article summarises the current status of the superstring approach to the problem, the status of the Ashtekar program, and problem of time in quantum gravity.

6612 Techniques of General Use in Physics

Refer also to citation(s) 31285

30868 (ANL/PHY/CP–86667) **Crystalline beams.** Schiffer, J.P. (Argonne National Lab., IL (United States)). Argonne National Lab., IL (United States). [1995]. 4p. Sponsored by USDOE, Washington, DC (United States). DOE Contract W-31-109-ENG-38. (CONF-950512–286: Particle accelerator conference, Dallas, TX

(United States), 1-5 May 1995). Order Number DE95013547. Source: OSTI; NTIS; INIS; GPO Dep.

A beam of confined charged particles, that are cooled to the extreme of the space-charge dominated regime, where the relative motion of particles within the beam is small compared to their Coulomb potential energies, will crystallize in a unique form of condensed matter. Such a system of particles can be simulated using the method of Molecular Dynamics, which explicitly includes the interaction between all pairs of particles and uses repeating cells to simulate the effects of a long beam. Within the molecular dynamics simulations typically a few thousand particles are followed in time, allowed to equilibrate, and then the velocities are gradually scaled down while still allowing the system to maintain equilibrium. To reach a cold equilibrium value requires 10-100 thousand iterations, corresponding to real times on the order of a few thousand betatron periods.

30869 (BNL–62048) **Far field acceleration.** Fernow, R.C. Brookhaven National Lab., Upton, NY (United States). Jul 1995. 54p. Sponsored by USDOE, Washington, DC (United States). DOE Contract AC02-76CH00016. (CONF-9506249–1: Advanced Accelerator Physics school, Beijing (China), 14-17 Jun 1995). Order Number DE95016506. Source: OSTI; NTIS; INIS; GPO Dep.

Far fields are propagating electromagnetic waves far from their source, boundary surfaces, and free charges. The general principles governing the acceleration of charged particles by far fields are reviewed. A survey of proposed field configurations is given. The two most important schemes, Inverse Cerenkov acceleration and Inverse free electron laser acceleration, are discussed in detail.

30870 (LA-UR–95-2463) **Nitrogen heat pipe for cryocooler thermal shunt.** Prenger, F.C. (Los Alamos National Lab., NM (United States)); Hill, D.D.; Daney, D.E.; Daugherty, M.A.; Green, G.F.; Roth, E.W. Los Alamos National Lab., NM (United States). [1995]. 10p. Sponsored by USDOE, Washington, DC (United States);Department of Defense, Washington, DC (United States). DOE Contract W-7405-ENG-36. (CONF-950722–6: Cryogenic engineering conference and international cryogenic materials conference, Columbus, OH (United States), 17-21 Jul 1995). Order Number DE95016912. Source: OSTI; NTIS; GPO Dep.

A nitrogen heat pipe was designed, built and tested for the purpose of providing a thermal shunt between the two stages of a Gifford-McMahan (GM) cryocooler during cooldown. The nitrogen heat pipe has an operating temperature range between 63 and 123 K. While the heat pipe is in the temperature range during the system cooldown, it acts as a thermal shunt between the first and second stage of the cryocooler. The heat pipe increases the heat transfer to the first stage of the cryocooler, thereby reducing the cooldown time of the system. When the heat pipe temperature drops below the triple point, the nitrogen working fluid freezes, effectively stopping the heat pipe operation. A small heat leak between cryocooler stages remains because of axial conduction along the heat pipe wall. As long as the heat pipe remains below 63 K, the heat pipe remains inactive. Heat pipe performance limits were measured and the optimum fluid charge was determined.

30871 (LBL–37439-Rev.) **An orthotropic source of thermal atoms.** Dinneen, T.; Ghiorso, A.; Gould, H. Lawrence Berkeley Lab., CA (United States). Jul 1995. 12p. Sponsored by USDOE, Washington, DC (United States). DOE Contract AC03-76SF00098. Order Number DE96001016. Source: OSTI; NTIS; GPO Dep.

A source of thermal atoms that emits 100% of its atoms into a narrow beam with small angular divergence is described. It uses both surface ionization and surface neutralization in conjunction with electric fields to selectively emit a highly directional (orthotropic) beam of neutral atoms. The ion recycling process can be modulated electronically and lends itself to scanning. This orthotropic source is ideal for the efficient use of rare atomic species, well suited for atomic clocks, essential in the efficient delivery of radioactive atoms to optical traps, and has potential to produce ultra high intensity beams of stable atoms.

30872 (NIFS-PROC–24) **Proceedings of the symposium on negative ion sources and their applications.** Kuroda, Tsutomu; Sasao, Mamiko (eds.). National Inst. for Fusion Science, Nagoya (Japan). Aug 1995. 137p. (In Japanese, English). (CONF-941288–: Symposium on negative ion sources and their applications, Nagoya (Japan), 26-27 Dec 1994). Order Number DE96701437. Source: OSTI; NTIS; INIS.

This issue is the collection of the papers presented at the title meeting. The 26 of the presented papers are indexed individually. (J.P.N.).

30873 (UCRL-JC–118362) **Measurement of the temperature of cold highly charged ions produced in an electron beam ion trap.** Beiersdorfer, P.; Decaux, V.; Widmann, K. Lawrence Livermore National Lab., CA (United States). 14 Sep 1994. 8p. Sponsored by USDOE, Washington, DC (United States). DOE Contract W-7405-ENG-48. (CONF-940922–9: 7. international conference on physics of highly charged ions, Vienna (Austria), 19-23 Sep 1994). Order Number DE95011727. Source: OSTI; NTIS; GPO Dep.

The temperature of highly charged titanium ions produced and trapped in an electron beam ion trap was determined by precisely measuring the broadening of the emission line profile caused by the thermal Doppler motion. The measured temperature ranges from about 700 eV for deeply trapped ions to about 70 eV for ions in a shallow trap. The latter value represents the lowest temperature at which the x-ray emission of collisonally excited heliumlike Ti^{20+} ions has ever been recorded, and the measured transitions represent the narrowest x-ray lines observed from highly charged titanium ions.

30874 (UCRL-JC–122108) **Recent results from the super EBIT.** Marrs, R.E. Lawrence Livermore National Lab., CA (United States). 15 Sep 1995. 15p. Sponsored by USDOE, Washington, DC (United States). DOE Contract W-7405-ENG-48. (CONF-950706–18: 19. international conference on the physics of electronic and the atomic collisions, Whistler (Canada), 26 Jul - 1 aug 1995). Order Number DE96000354. Source: OSTI; NTIS; INIS; GPO Dep.

The Super EBIT device at LLNL can produce and trap any highly charged ion at rest in the laboratory, including bare U^{92+} ions. Recently, the ionization cross sections for high-Z hydrogenlike ions have been measured for the first time, and measurements of the L-shell ionization cross sections for uranium ions are in progress. The two-electron contributions to the ground state energies of heliumlike ions have been directly measured using a novel technique, and spectra of 2s-2p transitions in highly ionized thorium and uranium have been used to test QED corrections to the energy levels of few electron high-Z ions. A new capability for the study of rare isotopes has been demonstrated. Ion cooling has been used to reduce the thermal broadening of x-ray emission lines to the point where natural line widths can be observed in some cases.

6613 Other Aspects of Physical Science

Refer also to citation(s) 28731, 30333, 30545, 30863, 30865, 30916, 30957, 31244, 31380, 31385

30875 (BNL–62058) **1Dynamical structure in paleoclimate data.** Stewart, H.B. Brookhaven National Lab., Upton, NY (United States). 1 Dec 1994. 18p. Sponsored by USDOE, Washington, DC (United States). DOE Contract AC02-76CH00016. (CONF-9404283–1: PACLIM workshop, Pacific Grove, CA (United States), 19-22 Apr 1994). Order Number DE95016507. Source: OSTI; NTIS; GPO Dep.

Deterministic chaos in dynamical systems offers a new paradigm for understanding irregular fluctuations. The theory of chaotic dynamical systems includes methods which can test whether any given set of time series data, such as paleoclimate proxy data, are consistent with a deterministic interpretation. Paleoclimate data with annual resolution and absolute dating provide multiple channels of concurrent time series; these multiple time series can be treated as potential phase space coordinates to test whether interannual climate variability is deterministic. Dynamical structure tests which take advantage of such multichannel data are proposed and illustrated by application to a simple synthetic model of chaos, and to two paleoclimate proxy data series.

30876 (CONF-940633–9) **An analytical method of predicting Lee-Kesler-Ploecker binary interaction coefficients: Part 1,**

For non-polar hydrocarbon mixtures. Sand, J.R. Oak Ridge National Lab., TN (United States). [1994]. 14p. Sponsored by USDOE, Washington, DC (United States). DOE Contract AC05-84OR21400. From 12. symposium on thermophysical properties; Boulder, CO (United States); 19-24 Jun 1994. Order Number DE95014033. Source: OSTI; NTIS; GPO Dep.

An analytical method is proposed for finding numerical values of binary interaction coefficients for non-polar hydrocarbon mixtures when the Lee-Kesler (LK) equation of state is applied. The method is based on solving simultaneous equations, which are Ploecker's mixing rules for pseudocritical parameters of a mixture, and the Lee-Kesler equation for the saturation line. For a hydrocarbon mixture, the method allows prediction of κ_{ij} interaction coefficients (ICs) which are close to values obtained by processing experimental p-v-t data on the saturation line and subsequent averaging. For mixtures of hydrocarbon molecules containing from 2 to 9 carbon atoms, the divergence between calculated and experimentally based ICs is no more than $\pm 0.4\%$. The possibility of extending application of this method to other non-polar substances is discussed.

30877 (ETDE/CH-mf–95787322, pp. 55-58) **Single-pulse measurements of the sound velocity in gases by laser-induced electrostrictive gratings.** Hubschmid, W. (Paul Scherrer Inst. (PSI), Villigen (Switzerland)); Bombach, R.; Hemmerling, B.; Stampanoni-Panariello, S. Paul Scherrer Inst. (PSI), Villigen (Switzerland). 1995. In *Paul Scherrer Institut annual report 1994. Annex V: PSI general energy technology newsletter 1994.* 123p. Source: OSTI; NTIS.

Laser-induced electrostrictive gratings have been applied to measure the sound velocity in various gases on a single-pulse basis. The gratings are generated by the interference of two parallel polarized, crossed excitation beams arising from a pulsed Nd:YAG laser at 532.1 nm, and are detected by diffracting a probe beam originating from a cw Ar^+ laser operating single-line at 514.5 nm. Measurements were performed in the overlap volume of unfocused and focused excitation beams. Using unfocused beams, the sound velocities in various gases at pressures of 5 bar were measured with a statistical error for single-pulse measurements of about 0.3 %. With focused beams, the accuracy of the measurements is reduced because of the propagation of the sound waves out of the smaller overlap volume of 0.2 mm length. Measurements with focused beams were performed in air and CO_2 with an error of about 1 %. (author) 4 figs., 1 tab., 7 refs.

30878 (ETDE/CH-mf–95787322, pp. 59-62) **CARS temperature measurements in laminar and turbulent high pressure flames.** Bombach, R. (Paul Scherrer Inst. (PSI), Villigen (Switzerland)); Hemmerling, B.; Kaeppeli, B.; Kreutner, W.; Kozlov, D. Paul Scherrer Inst. (PSI), Villigen (Switzerland). 1995. In *Paul Scherrer Institut annual report 1994. Annex V: PSI general energy technology newsletter 1994.* 123p. Source: OSTI; NTIS.

A mobile CARS system has been used to determine temperatures and their fluctuations in a high pressure combustion test rig with a maximum thermal power of 8 MW. Turbulent natural gas and oil flames have been studied up to a pressure of 14 bars. Because of the size of the combustion chamber, beam steering effects became a serious problem for this measuring technique. Temperature determinations in sooty oil flames rendered even more difficult due to the strong absorption of a part of the fundamental band in the N_2 CARS spectrum by C_2 radicals. Probability density functions of the temperature, each based on 1000 single shot measurements, have been determined at different radial and axial locations within the combustion chamber. (author) 6 figs., 10 refs.

30879 (ETDE/CH-mf–95787322, pp. 63-65) **Aspects of carbon dioxide CARS temperature metrology.** Kozlov, D. (Russian Academy of Sciences, General Physics Inst., Moscow (Russian Federation)); Bombach, R.; Hemmerling, B.; Kaeppeli, B.; Kreutner, W. Paul Scherrer Inst. (PSI), Villigen (Switzerland). 1995. In *Paul Scherrer Institut annual report 1994. Annex V: PSI general energy technology newsletter 1994.* 123p. Source: OSTI; NTIS.

Preliminary measurements have been performed to check the suitibility of CO_2 as a probe molecule for temperature measurements. A standard scanning CARS equipment with a resolution of approximately 0.1 cm^{-1} has been employed. The results suggest that CO_2 may be used for temperature determinations on the base of simple line ratios for gas densities above 10 amagat. For atmospheric pressure measurements the temperature range accessible with a reasonable signal-to-noise ratio lies below T=1500°C. Furthermore, saturation effects were found which perturb strongly the $\nu_1/2\nu_2$ Fermi dyad of CO_2 even at moderate laser intensity. (author) 3 figs., 7 refs.

30880 (FNAL/C–95/120) **Constraining omega and bias from the Stromlo-APM survey.** Loveday, J. Fermi National Accelerator Lab., Batavia, IL (United States). May 1995. 8p. Sponsored by USDOE, Washington, DC (United States);National Science Foundation, Washington, DC (United States);European Economic Community, Brussels (Belgium). DOE Contract AC02-76CH03000. (CONF-9503158–16: 30. Rencontres de Moriond on QCD and high energy interactions, Les Arcs (France), 19-26 Mar 1995). Order Number DE95015166. Source: OSTI; NTIS; INIS; GPO Dep.

Galaxy redshift surveys provide a distorted picture of the universe due to the non-Hubble component of galaxy motions. By measuring such distortions in the linear regime one can constrain the quantity $\beta = \Omega^{0.6}$ where Ω is the cosmological density parameter and b is the (linear) bias factor for optically-selected galaxies. In this paper we estimate β from the Stromlo-APM redshift survey by comparing the amplitude of the direction-averaged redshift space correlation function to the real space correlation function. We find a 95% confidence upper limit of $\beta = 0.75$, with a 'best estimate' of $\beta \approx 0.48$. A bias parameter $b \approx 2$ is thus required if $\Omega \equiv 1$. However, higher-order correlations measured from the APM galaxy survey indicate a low value for the bias parameter $b \approx 1$, requiring that $Q \lesssim 0.6$.

30881 (IC–95/106) **Stability analysis of a general age-dependent vaccination model of a vertically transmitted disease.** El Doma, M. International Centre for Theoretical Physics, Trieste (Italy). Jul 1995. 14p. Order Number DE96602808. Source: OSTI; NTIS (US Sales Only); INIS.

An SIR epidemic model of a general age-dependent vaccination of a vertically as well as horizontally transmitted disease is investigated when the population is in steady state and the fertility, mortality and removal rates depends on age. We determine the steady states and examine their stabilities. (author). 24 refs.

30882 (IC–95/128) **Generalized KdV equation for fluid dynamics and q-differential approach.** Ionescu, R.A. (International Centre for Theoretical Physics, Trieste (Italy)); Ludu, A.; Greiner, W. International Centre for Theoretical Physics, Trieste (Italy). Jun 1995. 12p. Order Number DE96602170. Source: OSTI; NTIS (US Sales Only); INIS.

We generalize the nonlinear one-dimensional equation of a fluid layer for any depth as an infinite order differential equation for the steady waves. This equation can be written as a q-differential one, with its general solution written as a power series expansion with coefficients satisfying a nonlinear recurrence relation. In the limit of long and shallow water (shallow channels) we reobtain the well known KdV equation together with its single-soliton solutions. (author). 19 refs.

30883 (IC–95/143) **Mass dependence of self-diffusion in isotopic fluids.** Tankeshwar, K. International Centre for Theoretical Physics, Trieste (Italy). Jul 1995. 13p. Order Number DE96602171. Source: OSTI; NTIS (US Sales Only); INIS.

By using the Mori memory function formalism we have derived a simple relation for the mass dependence of self diffusion of a particle in an isotopic fluid. It has been shown that self- diffusion coefficient of a massive particle for a very large mass ratio (≥ 25) has a unique value at a given density and temperature which is 1 $\sqrt{2}$ times the self-diffusion coefficient of the fluid. The prediction of the formula has been supported by the recent molecular dynamics data on Lennard Jones fluids. We have also studied the effect of density and temperature on mass dependent self-diffusion coefficient. It is found that the ratio of self diffusion coefficient of the heavy particle to that of fluid is weakly dependent on thermodynamic state of the fluid. (author). 18 refs, 4 figs, 1 tab.

30884 (INEL–95/00106) **Discovery of water ice nearly everywhere in the solar system.** Zuppero, A. Idaho National Engineering Lab., Idaho Falls, ID (United States). [1995]. 10p. Sponsored by USDOE, Washington, DC (United States). DOE

Contract AC07-94ID13223. (CONF-9506271–1: 3. international symposium on mine mechanization and automation, Golden, CO (United States), 12-14 Jun 1995). Order Number DE96001614. Source: OSTI; NTIS; GPO Dep.

During the last decade we have discovered sources of accessible water in some form nearly everywhere in the solar system. Water ice has been found on the planet Mercury; probably on the Earth's Moon; on Mars; on near Earth objects; on comets whose orbits frequently come close to that of Earth's orbit; probably on Ceres, the largest inner asteroid; and on comets previously and incorrectly considered to be out of practical reach. The comets also provide massive quantities of hydrocarbons, similar to oil shale. The masses of either water or hydrocarbons are measured in units of cubic kilometers. The water is key to space transportation because it can be used as a rocket propellant directly, and because thermal process alone can be used to convert it and hydrocarbons into hydrogen, the highest performing rocket propellant. This presentation outlines what is currently known about the locations of the water ice, and sketches the requirements and environments of missions to prospect for and assay the water sources.

30885 (INIS-BR–3540, pp. 71-74) **Formalism and generalized statistics systems.** Souza, M.M. de (Espirito Santo Univ., Vitoria, ES (Brazil). Dept. de Fisica e Quimica). Sociedade Brasileira de Fisica, Sao Paulo, SP (Brazil). 1993. 251p. (In Portuguese). (CONF-9109557–: 12. national meeting on particle physics and fields, Caxambu (Brazil), 18-22 Sep 1991). In *Proceedings of the 12. National Meeting on Particle Physics and Fields*. Order Number DE96602594. Source: OSTI; NTIS; INIS.

Any equation can be written as null eigenvalue equation of the polynomial function of permutation operators. The polynomial operator defines an equation class. Which has the some algebra and the name topology defined on suitable basis of expansion of their eigenfunctions. The algebra and topology classify the equation system according to statistics of their solutions, the behaviour under permutations. The statistics of Base-Einstein, Fermi-Dirac and exotic systems (anyons) are included in these class. (M.C.K.).

30886 (INIS-BR–3540, pp. 95-98) **Study on lateral distribution of neutron cascade induced by only one nucleon in the atmosphere.** Bellandi, J. (Universidade Estadual de Campinas, SP (Brazil). Inst. de Fisica); Covolan, R.J.M.; Dobrigkeit, C.; Costa, C.G.S.; Mundim, L.M. Sociedade Brasileira de Fisica, Sao Paulo, SP (Brazil). 1993. 251p. (In Portuguese). (CONF-9109557–: 12. national meeting on particle physics and fields, Caxambu (Brazil), 18-22 Sep 1991). In *Proceedings of the 12. National Meeting on Particle Physics and Fields*. Order Number DE96602594. Source: OSTI; NTIS; INIS.

Some aspects of lateral behavior of nucleonic cascade induced by only one nucleon which interacts with the atmosphere, such as: energy dependence, height of interaction, lateral dispersion and average matter quantity crossed by cascade, are discussed. (M.C.K.). 6 refs, 6 figs.

30887 (LA–13023-MS) **Spatial and frequency coherence of oblique, one-hop, high-frequency paths.** Fitzgerald, T.J. Los Alamos National Lab., NM (United States). Oct 1995. 34p. Sponsored by USDOE, Washington, DC (United States). DOE Contract W-7405-ENG-36. Order Number DE96001439. Source: OSTI; NTIS; GPO Dep.

We consider the effect of random index of refraction fluctuations upon long-distance, ionospherically-reflected, hf paths. Along with deterministic effects such as multipath and dispersion, such fluctuations have a deleterious impact on hf communication including nonabsorptive fading, time-of-arrival spread, angle-of-arrival spread, and Doppler spread. We develop a formalism to calculate the mutual coherence functions for spatial and frequency separations based upon a path integral solution of the parabolic wave equation for a single refracted path through an ionosphere which contains random electron density fluctuations. The statistics of the hf path depend directly on the strength and statistics of the electron density fluctuations; we model the spatial power spectrum of the density fluctuation as a power law behavior versus frequency and with outer and inner scales.

30888 (LAMP–95/5) **Bright and dark solitary wave propagation and bistability in the anomalous dispersion region of optical waveguides with third- and fifth-order nonlinearities.** Lamp Series Report (Laser, Atomic and Molecural Physics), Lamp Series Report (Laser, Atomic and Molecural Physics). Pushkarov, D. (Bulgarian Academy of Sciences, Sofia (Bulgaria). Inst. of Solid State Physics); Tanev, S. International Centre for Theoretical Physics, Trieste (Italy). Jun 1995. 36p. Order Number DE96602172. Source: OSTI; NTIS (US Sales Only); INIS.

A unified analysis of all existing solitary wave solutions of the cubic-quintic nonlinear Schroedinger equation is made concretely considering a monomode step-index optical fibre with third- and fifth-order nonlinearities in the anomalous dispersion frequency region. Different aspects of the saturation effect due to the fifth-order nonlinearity, such as solitary wave propagation and bistability, are considered. All results obtained are directly applicable to the cases of spatial solitons and optical beam self-action in highly nonlinear media. The possible applications in optical switching experiments and communication systems are discussed. (author). 34 refs, 6 figs.

30889 (LA-UR–95-1475) **The coherent acceleration of ultra high energy cosmic rays and the galactic dynamo.** Colgate, S.A. Los Alamos National Lab., NM (United States). [1995]. 5p. Sponsored by USDOE, Washington, DC (United States). DOE Contract W-7405-ENG-36. (CONF-9508122–1: 24. international cosmic rays conference (ICRC), Rome (Italy), 28 Aug - 8 sep 1995). Order Number DE95011996. Source: OSTI; NTIS; GPO Dep.

In order to accelerate cosmic rays to ultra high energy, $>10^{18}$ ev, requires that the step size in energy in a diffusive process be very much larger than occurs in galactic or extra galactic hydrodynamic mechanisms where $\Delta E/F \sim v/c \sim 1/300$ per step. This step size requires $>10^5$ scatterings per doubling in energy (the shock mechanism) and therefore $<10^{-5}$ energy loss per scattering. Coherent acceleration (CA), on the other hand, is proposed in which the energy gained, ΔE per particle in the CA region is very much larger so that only one or several scatterings are required to reach the final energy. The power law spectrum is created by the probability of loss from the CA region where this probability is inversely proportional to the particle's rigidity, E. Therefore the fractional loss in number per fractional gain in energy, $dN/N \sim -\Gamma\, dE/E$, results in a power law spectrum. CA depends upon the electric field, $E = \eta J$, J, the current density, in a force free field, where magnetic helicity, $J=\alpha B$, arises universally in all evolving mass condensations due to twisting of magnetic flux by the large number of turns before pressure support. The acceleration process is E^*v, where universe beam instabilities enhance η leading to phased coherent acceleration (PCA). The result of the energy transfer from field energy to matter energy is the relaxation of the field helicity, or reconnection but with $J \| B$ rather than $J \perp B$.

30890 (LA-UR–95-1634) **Gamma-ray bursts from planetoid accretion onto fast galactic neutron stars.** Colgate, S.A. (Los Alamos National Lab., NM (United States)); Leonard, P.J.T. Los Alamos National Lab., NM (United States). [1995]. 8p. Sponsored by USDOE, Washington, DC (United States);Maryland Univ., College Park, MD (United States). DOE Contract W-7405-ENG-36. (CONF-9508160–1: 24. ICR conference, Rome (Italy), 28 Aug - 8 sep 1995). Order Number DE95015338. Source: OSTI; NTIS; GPO Dep.

We propose a Galactic model for the isotropic component of gamma-my bursts (GB's) based upon high-velocity neutron stars (NS's) that have accretion disks. The fast NS's are formed in tidally locked binaries, leading to a unique fast NS population. The tidal locking occurs due to the meridional circulation caused by the conservation of angular momentum of the tidal lobes. These same lobes perturb the subsequent collapse to a supernova and a slowly rotating NS. Following the collapse and explosion, subsequent accretion occurs on the rear side of the initially perturbed NS. A resulting instability leads to run-away acceleration of the neutron star by neutrino emission from the hot accreted matter. The recoil of the NS is oriented towards the companion, but misses because of the initial orbital motion. The near miss captures matter from the companion and forms a disk around the NS. The disk material is captured from the material ablated from a pre-supernova binary

companion. Accretion onto the neutron star from this initially gaseous disk due to the enhanced "alpha" viscosity results initially in the soft gamma-ray repeater phase, $\sim 10^4$ y. Later, after the neutron star has moved ~30 kpc from its birthplace, solid bodies form in the disk, and accrete to planetoid size bodies after $\sim 3 \times 10^7$ years. Some of these planetoid bodies, with a mass of $\sim 10^{21--22}$ g, are perturbed into being captured by the magnetic field of the NS to create gamma-ray bursts. The high velocity and millions of years delay in forming planetoids, results in galactic isotropy. The depletion of planetoids by planet accretion after 10^8 years and the evolution of planetoid mass with time results in the observed value of V/V_{max}. The hard spectrum is produced by the collision with, twisting, and ultimately the reconnection, of the NS magnetic field.

30891 (LA-UR–95-1735) **Gamma-ray bursts from fast, Galactic neutron stars.** Colgate, S.A. (Los Alamos National Lab., NM (United States)); Leonard, P.J.T. Los Alamos National Lab., NM (United States). [1995]. 6p. Sponsored by USDOE, Washington, DC (United States). DOE Contract W-7405-ENG-36. (CONF-9504198–1: AIP workshop on high velocity neutron stars, La Jolla, CA (United States), 15 Apr 1995). Order Number DE95015319. Source: OSTI; NTIS; GPO Dep.

What makes a Galacic model of gamma-ray bursts (GBs) feasible is the observation of a new population of objects, fast neutron stars, that are isotropic with respect to the Galaxy following a finite period, ~30My, after their formation. Our Galactic model for the isotropic component of (GBs) is based upon these high-velocity neutron stars (NSs) that have accretion disks. The fast NSs are formed in tidally locked binaries, where tidal locking occurs due to the meridional circulation caused by the conservation of angular momentum of the tidal lobes. These same lobes perturb the subsequent collapse to a supernova and forming a slowly rotating NS. Following the collapse to a NS and explosion, subsequent accretion occurs on the rear side of the initially perturbed NS, resulting in a run-away acceleration of the neutron star by neutrino emission from the hot accreted matter. The recoil momentum of the relativistic neutrino emission from the localized, down flowing matter far exceeds the momentum drag of the accreted matter. The recoil of the NS may be oriented towards the companion, but misses because of the initial orbital motion. The near miss captures matter from the companion and forms a disk around the NS. Accretion onto the neutron star from this initially gaseous disk due to the "alpha" viscosity results initially in the soft gamma-ray repeater phase, $\sim 10^4$ yr. After the neutron star has moved ~30 kpc from its birthplace, solid bodies form in the disk, and accrete to planetoid size bodies after $\sim 3 \times 10^7$ years. Some of these planetoid bodies, with a mass of $\sim 10^{21 to 22}$ g, are perturbed into being captured by the magnetic field of the NS to create GBs. The high velocity and millions of years delay in forming planetoids, results in isotropy.

30892 (LA-UR–95-2446) **Transionospheric chirp event classifier.** Argo, P.E.; Fitzgerald, T.J.; Freeman, M.J. Los Alamos National Lab., NM (United States). [1995]. 8p. Sponsored by USDOE, Washington, DC (United States). DOE Contract W-7405-ENG-36. (CONF-9508153–1: Applications of time-frequency and time-scale methods, Coventry (United Kingdom), 30-31 Aug 1995). Order Number DE95016882. Source: OSTI; NTIS; GPO Dep.

In this paper we will discuss a project designed to provide computer recognition of the transionospheric chirps/pulses measured by the Blackbeard (BB) satellite, and expected to be measured by the upcoming FORTE satellite. The Blackbeard data has been perused by human means – this has been satisfactory for the relatively small amount of data taken by Blackbeard. But with the advent of the FORTE system, which by some accounts might "see" thousands of events per day, it is important to provide a software/hardware method of accurately analyzing the data. In fact, we are providing an onboard DSP system for FORTE, which will test the usefulness of our Event Classifier techniques in situ. At present we are constrained to work with data from the Blackbeard satellite, and will discuss the progress made to date.

30893 (LA-UR–95-2664) **Suprathermal electron loss cone distributions in the solar wind: Ulysses observations.** Phillips, J.L. (Los Alamos National Lab., NM (United States)); Feldman, W.C.; Gosling, J.T.; Hammond, C.M.; Forsyth, R.J. Los Alamos National Lab., NM (United States). [1995]. 12p. Sponsored by USDOE, Washington, DC (United States);National Aeronautics and Space Administration, Washington, DC (United States). DOE Contract W-7405-ENG-36. (CONF-9506256–1: 8. international solar wind conference, Dana Point, CA (United States), 26-30 Jun 1995). Order Number DE95016967. Source: OSTI; NTIS; GPO Dep.

We present observations by the Ulysses solar wind plasma experiment of a new class of suprathermal electron signatures. At low solar latitudes and heliocentric distances beyond 3.37 AU Ulysses encountered seven intervals, ranging in duration from 1 hour to 22 hours, in which the suprathermal distributions included an antisunward field-aligned beam and a return population with a flux dropout typically spanning ±60 ft from the sunward field-aligned direction. All events occurred between the forward and reverse shocks or waves bounding corotating interaction regions (CIRs). The observations support a scenario in which the sunward-moving electrons result from reflection of the prevailing antisunward field-aligned beam at magnetic field compressions downstream from the spacecraft, with wide loss cones caused by the relatively weak mirror ratio. This hypothesis requires that the field magnitude within the CIRs actually increased locally with increasing field-aligned distance from the Sun.

30894 (LA-UR–95-2783) **Semi-Lagrangian shallow water modeling on the CM-5.** Nadiga, B.T. (Los Alamos National Lab., NM (United States)); Margolin, L.G.; Smolarkiewicz, P.K. Los Alamos National Lab., NM (United States). [1995]. 8p. Sponsored by USDOE, Washington, DC (United States). DOE Contract W-7405-ENG-36. (CONF-9507179–2: Parallel CFD, Pasadena, CA (United States), Jul 1995). Order Number DE96000006. Source: OSTI; NTIS; GPO Dep.

We discuss the parallel implementation of a semi-Lagrangian shallow-water model on the massively parallel Connection Machine CM-5. The four important issues we address in this article are (i) two alternative formulations of the elliptic problem and their relative efficiencies, (ii) the performance of two successive orders of a generalized conjugate residual elliptic solver, (iii) the time spent in unstructured communication – an unavoidable feature of semi-Lagrangian schemes, and (iv) the scalability of the algorithm.

30895 (LA-UR–95-2853) **Magnetic topologies of coronal mass ejection events: Effects of 3-dimensional reconnection.** Gosling, J.T. Los Alamos National Lab., NM (United States). [1995]. 16p. Sponsored by USDOE, Washington, DC (United States). DOE Contract W-7405-ENG-36. (CONF-9506256–3: 8. international solar wind conference, Dana Point, CA (United States), 26-30 Jun 1995). Order Number DE96000015. Source: OSTI; NTIS; GPO Dep.

New magnetic loops formed in the corona following coronal mass ejection, CME, liftoffs provide strong evidence that magnetic reconnection commonly occurs within the magnetic "legs" of the departing CMEs. Such reconnection is inherently 3-dimensional and naturally produces CMEs having magnetic flux rope topologies. Sustained reconnection behind CMEs can produce a mixture of open and disconnected field lines threading the CMES. In contrast to the results of 2-dimensional reconnection. the disconnected field lines are attached to the outer heliosphere at both ends. A variety of solar and solar wind observations are consistent with the concept of sustained 3-dimensional reconnection within the magnetic legs of CMEs close to the Sun.

30896 (LA-UR–95-2869) **Precision solid liner experiments on Pegasus II.** Bowers, R.L. (and others); Brownell, J.H.; Lee, H. Los Alamos National Lab., NM (United States). [1995]. 6p. Sponsored by USDOE, Washington, DC (United States). DOE Contract W-7405-ENG-36. (CONF-950750–37: 10. Institute of Electrical and Electronics Engineers (IEEE) pulsed power conference, Albuquerque, NM (United States), 10-13 Jul 1995). Order Number DE96000032. Source: OSTI; NTIS; GPO Dep.

Pulsed power systems have been used in the past to drive solid liner implosions for a variety of applications. In combination with a variety of target configurations, solid liner drivers can be used to compress working fluids, produce shock waves, and study material properties in convergent geometry. The utility of such a driver depends in part on how well-characterized the drive conditions are.

This, in part, requires a pulsed power system with a well-characterized current wave form and well understood electrical parameters. At Los Alamos, the authors have developed a capacitively driven, inductive store pulsed power machine, Pegasus, which meets these needs. They have also developed an extensive suite of diagnostics which are capable of characterizing the performance of the system and of the imploding liners. Pegasus consists of a 4.3 MJ capacitor bank, with a capacitance of 850 μf fired with a typical initial bank voltage of 90 kV or less. The bank resistance is about 0.5 mΩ, and bank plus power flow channel has a total inductance of about 24 nH. In this paper the authors consider the theory and modeling of the first precision solid liner driver fielded on the LANL Pegasus pulsed power facility.

30897 (LA-UR–95-2888) **Ulysses solar wind plasma observations from peak southerly latitude through perihelion and beyond.** Phillips, J.L. (Los Alamos National Lab., NM (United States)); Bame, S.J.; Feldman, W.C.; Gosling, J.T.; McComas, D.J.; Goldstein, B.E.; Neugebauer, M.; Hammond, C.M. Los Alamos National Lab., NM (United States). [1995]. 14p. Sponsored by National Aeronautics and Space Administration, Washington, DC (United States). DOE Contract W-7405-ENG-36. (CONF-9506256–2: 8. international solar wind conference, Dana Point, CA (United States), 26-30 Jun 1995). Order Number DE96000003. Source: OSTI; NTIS; GPO Dep.

We present Ulysses solar wind plasma data from the peak southerly latitude of −80.2° through +64.9° latitude on June 7, 1995. Ulysses encountered fast wind throughout this time except for a 43° band centered on the solar equator. Median mass flux was nearly constant with latitude, while speed and density had positive and negative poleward gradients, respectively. Solar wind momentum flux was highest at high latitudes, suggesting a latitudinal asymmetry in the heliopause cross section. Solar wind energy flux density was also highest at high latitudes.

30898 (LA-UR–95-2969) **He abundance variations in the solar wind: Observations from Ulysses.** Barraclough, B.L. (Los Alamos National Lab., NM (United States)); Gosling, J.T.; Phillips, J.L.; McComas, D.J.; Feldman, W.C.; Goldstein, B.E. Los Alamos National Lab., NM (United States). [1995]. 15p. Sponsored by National Aeronautics and Space Administration, Washington, DC (United States). DOE Contract W-7405-ENG-36. (CONF-9506256–4: 8. international solar wind conference, Dana Point, CA (United States), 26-30 Jun 1995). Order Number DE96000023. Source: OSTI; NTIS; GPO Dep.

The Ulysses mission is providing the first opportunity to observe variations in solar wind plasma parameters at heliographic latitudes far removed from the ecliptic plane. We present an overview of the solar wind speed and the variability in helium abundance, [He] data on [He] in six high latitude coronal mass ejections (CMEs), and a superposed epoch analysis of [He] variations at the seven heliospheric current sheet (HCS) crossings made during the rapid-latitude-scan portion of the mission. The differences in the variability of the solar wind speed and [He] in high latitude and equatorial regions are quite striking. Solar wind speed is generally low but highly variable near the solar equator, while at higher latitudes the average speed is quite high with little variability. [He] can vary over nearly two decades at low solar latitudes, while at high latitudes it varies only slightly. In contrast to the high [He] that is commonly associated with CMEs observed in the ecliptic, none of the six high-speed CMEs encountered at high southern heliographic latitudes showed any significant variation in helium content. A superposed epoch analysis of the [He] during all seven HCS crossings made as Ulysses passed from the southern to northern solar hemisphere shows the expected [He] minimum near the crossing and a broad region of low [He] around the crossing time. We discuss how our solar wind [He] observations may provide an accurate measure of the helium composition for the entire convective zone of the Sun.

30899 (LA-UR–95-3005) **The DBV stars: Progress and problems.** Bradley, P.A. Los Alamos National Lab., NM (United States). [1995]. 10p. Sponsored by USDOE, Washington, DC (United States). DOE Contract W-7405-ENG-36. (CONF-9507169–1: Whole earth telescope workshop, Ames, IA (United States), Jul 1995). Order Number DE96000029. Source: OSTI; NTIS; GPO Dep.

The DB white dwarfs comprise the majority of the 20% or so of non-DA white dwarfs, and have effective temperatures between 11,000 K and 30,000 K. The hottest DBs define the cool end of the so called "DB gap" that lies between 30,000 K and 45,000 K; in this region, no helium atmosphere white dwarf is known. The existence of this gap presents a great puzzle concerning the origin and evolution of helium atmosphere white dwarfs. Asteroseismology of the DBV stars as a class will tell scientists what DBs just below the red edge of the DB gap are like. This, coupled with structural understanding of the pulsating PG 1159 stars, the interacting binary white dwarfs (IBWDs), and white dwarf evolution calculations should fill in the gaps of knowledge about the DB white dwarfs and their origins. Here, the author describes the current status of understanding of DBV white dwarf structure via asteroseismology, with an emphasis on what was learned through Whole Earth Telescope data.

30900 (LA-UR–95-3092) **Electrical resistivity measurements of a dense aluminum plasma.** Benage, J.F. Jr.; Shanahan, W.R.; Murillo, M.S. Los Alamos National Lab., NM (United States). [1995]. 8p. Sponsored by USDOE, Washington, DC (United States). DOE Contract W-7405-ENG-36. (CONF-9509222–1: Strongly coupled plasmas conference, Binz (Germany), 11-15 Sep 1995). Order Number DE96000049. Source: OSTI; NTIS; INIS; GPO Dep.

In this paper the authors report results of experiments to measure the electrical resistivity for a dense strongly coupled aluminum plasma. These plasmas cover the density and temperature range from near solid density and room temperature to .03x solid and 40 eV. These conditions give values of Λ = 5–6. The results indicate the resistivity is higher in this regime than most theories. Only the results of some density functional calculations give results consistent with the data.

30901 (LA-UR–95-3128) **Effects of corotating interaction regions on ULYSSES high energy particles.** Droege, W. (Kiel Univ. (Germany). Inst. fuer Kernphysik); Kunow, H.; Raviart, A. Los Alamos National Lab., NM (United States). [1995]. 13p. Sponsored by National Aeronautics and Space Administration, Washington, DC (United States). DOE Contract W-7405-ENG-36. DARA Grant no. 50ON9106. (CONF-9506256–5: 8. international solar wind conference, Dana Point, CA (United States), 26-30 Jun 1995). Order Number DE96000037. Source: OSTI; NTIS; GPO Dep.

Since June 1992 the Kiel Electron Telescope on board ULYSSES measures variations of more than 10% in the fluxes of high energy H and He showing a periodicity of about 26 days in coincidence with the passage of corotating interaction regions. (CIR). At low energies MeV protons are accelerated at the shocks of the CIRs. These effects are observed up to high southern latitudes, where the signature of a CIR is no longer visible in plasma or magnetic field data. After passing over the south polar cap ULYSSES has now returned to the solar equator and climbs up to the north pole. In this paper we study the relative intensity variations with latitude and the latitude dependence at solar distances smaller than ever studied before.

30902 (LBL–37389) **Resonant second harmonic generation in potassium vapor.** Kim, D. (Univ. of California, Berkeley, CA (United States). Dept. of Physics); Mullin, C.S.; Shen, Y.R. Lawrence Berkeley Lab., CA (United States). Jun 1995. 4p. Sponsored by USDOE, Washington, DC (United States). DOE Contract AC03-76SF00098. (CONF-9506262–1: 12. international conference on laser spectroscopy, Piza (Italy), 11-16 Jun 1995). Order Number DE96000122. Source: OSTI; NTIS; INIS; GPO Dep.

Picosecond pulses are used to study resonant second harmonic generation in potassium vapor. Although the process is both microscopically and macroscopically forbidden, it can readily be observed. The results can be quantitatively understood by a multiphoton-ionization-initiated, dc-field-induced, coherent transient model.

30903 (NEDO-IT–9307) **Report on investigation and research concerning technology using small size high-intensity synchrotron radiation (SR).** New Energy and Industrial Technology Development Organization, Tokyo (Japan). Mar 1994. 155p. (In

Japanese). Order Number DE96704381. Source: OSTI; NTIS; Available from New Energy and Industrial Technology Development Organization, Sunshine 60, 30F 1-1, 3-chome, Higashi-Ikebukuro, Toshima-ku, Tokyo, Japan.

Technology of using small scale high-intensity synchrotron SR was investigated for the wide-range development and application, covering basic science, industrial application, and medical diagnosis. SR is an electromagnetic wave emitted, thanks to their centripetal acceleration, by electrons moving in the magnetic field, which covers a wide spectrum ranging from infrared rays to X-rays. Accordingly, it constitutes an energy source expected to apply to the structural analysis and evaluation of matters (structural analysis using diffraction and dispersion, electronic state analysis using photoelectron spectroscopy, etc.), super-fine working (lithography, etching, etc.), creation of new chemical substances, and medicine and medical diagnosis (X-ray CT, etc.). The high-intensity SR now under construction will deal with an unconventionally high energy and high-intensity domain. The small-size SR, capable of radiating high energy ranging from soft X-rays to long wavelengths, is expected to be useful in industrial fields that will include fine working, synthesis of new materials, and the study of the structure of functional matters. Concerning the small-size SR useful for the industrial circle, the existing sources of the SR, and the fields wherein the SR is currently in use and what future has in store for SR, are reported. 201 refs., 65 figs., 46 tabs.

30904 (PNL-SA–25847) **Validation study of air-sea gas transfer modeling.** Asher, W.E. (Pacific Northwest Lab., Richland, WA (United States)); Farley, P.J.; Leifer, I.S. Pacific Northwest Lab., Richland, WA (United States). Jul 1995. 4p. Sponsored by USDOE, Washington, DC (United States). DOE Contract AC06-76RL01830. (CONF-9507157–1: 3. international symposium on air-water gas transfer, Heidelberg (Germany), 24-27 Jul 1995). Order Number DE95016806. Source: OSTI; NTIS; GPO Dep.

Laboratory results have demonstrated the importance of bubble plumes to air-water gas transfer (Asher et al., 1994). Bubble plumes enhance gas transfer by disrupting surface films, by directly transporting a gas, and by the creation of turbulence. Models of bubble gas transfer have been developed by different authors (Atkinson, 1973; Memery and Merlivat, 1985; Woolf and Thorpe, 1991) to determine the magnitude of gas transfer due to bubbles. Laboratory measurements of both the gas transfer rate k_L, and the bubble distribution ϕ in a whitecap simulation tank (WST) have allowed these models to be validated and deficiencies in the theoretical assumptions to be explored. In the WST, each bucket tip simulates a wave breaking event. Important tests of these models include whether they can explain the experimentally determined solubility and Schmidt number dependency of k_L, predict the time varying bubble concentrations, predict the evasion-invasion asymmetry, and predict the fraction of k_L due to bubble plumes. Four different models were tested, a steady state model (Atkinson, 1973), a non-turbulence model with constant bubble radius (Memery and Merlivat, 1985), a turbulence model with constant bubble radius (Wolf and Thorpe, 1991), and a turbulence model with varying bubble radius. All models simulated multiple bubble tip cycles. The two turbulence models were run for sufficient tip cycles to generate statistically significant number of eddies (#>50) for bubbles affected by turbulence ($V_B \leq V_T$), found to be at least four tip cycles. The models allowed up to nine gases simultaneously and were run under different conditions of trace and major gas concentrations and partial pressures.

30905 (SLAC-PUB–95-6915) **Black-hole astrophysics.** Bender, P. (Univ. of Colorado, Boulder, CO (United States)); Bloom, E.; Cominsky, L. Stanford Linear Accelerator Center, Menlo Park, CA (United States); Colorado Univ., Boulder, CO (United States). Jul 1995. 11p. Sponsored by USDOE, Washington, DC (United States);Statens Naturvidenskabelige Forskningsraad, Copenhagen (Denmark). DOE Contract AC03-76SF00515 ; FG02-91ER40672. Grant N 9401635. (CONF-9406269–5: Snowmass 94: particle and astrophysics in the next millenium, Snowmass, CO (United States), 29 Jun - 14 jul 1994). Order Number DE95017367. Source: OSTI; NTIS; GPO Dep.

Black-hole astrophysics is not just the investigation of yet another, even if extremely remarkable type of celestial body, but a test of the correctness of the understanding of the very properties of space and time in very strong gravitational fields. Physicists' excitement at this new prospect for testing theories of fundamental processes is matched by that of astronomers at the possibility to discover and study a new and dramatically different kind of astronomical object. Here the authors review the currently known ways that black holes can be identified by their effects on their neighborhood–since, of course, the hole itself does not yield any direct evidence of its existence or information about its properties. The two most important empirical considerations are determination of masses, or lower limits thereof, of unseen companions in binary star systems, and measurement of luminosity fluctuations on very short time scales.

30906 (UCRL-ID–120467) **Alternative algorithms for computational fluid dynamics. Final report.** Ladd, A.J.C. Lawrence Livermore National Lab., CA (United States). 3 Mar 1995. 9p. Sponsored by USDOE, Washington, DC (United States). DOE Contract W-7405-ENG-48. Order Number DE95012482. Source: OSTI; NTIS; GPO Dep.

Fluid flow is conventionally modeled by finite difference or finite element approximations to the Navier-Stokes equations. The key problem in such calculations is devising an efficient computational mesh on which to solve the equations; if the geometry is complex, extensive human intervention is usually necessary. Thus these methods are unsuitable for problems such as the motion of solid particulates in suspension, where there may be many thousands of objects whose positions are constantly varying over the course of the simulation. Over the past few years I have developed an alternative strategy for modeling solid-fluid flows, based on a discrete Boltzmann model, in which the particle velocities are sampled from a small well-chosen set, commensurate with the underlying spatial lattice. This leads to a simple and fast numerical algorithm which can solve fluid flow problems with high accuracy on relatively crude spatial meshes. Thus it has been possible to track the motion of around 1000 hydrodynamically interacting particles on a desktop workstation. A preliminary account of some of this work was published in Physical Review Letters; a complete account of the method is given in two papers published by the Journal of Fluid Mechanics.

30907 (UCRL-ID–122106) **The evolution and explosion of massive Stars II: Explosive hydrodynamics and nucleosynthesis.** Woosley, S.E. (California Univ., Santa Cruz, CA (United States)); Weaver, T.A. Lawrence Livermore National Lab., CA (United States). 30 Aug 1995. 300p. Sponsored by USDOE, Washington, DC (United States). DOE Contract W-7405-ENG-48. Order Number DE96000829. Source: OSTI; NTIS; GPO Dep.

The nucleosynthetic yield of isotopes lighter than A = 66 (zinc) is determined for a grid of stellar masses and metallicities including stars of 11, 12, 13, 15, 18, 19, 20, 22, 25, 30, 35, and 40 $M_\odot$ and metallicities Z = 0, 10^{-4}, 0.01, 0.1, and 1 times solar (a slightly reduced mass grid is employed for non-solar metallicities). Altogether 78 different model supernova explosions are calculated. In each case nucleosynthesis has already been determined for 200 isotopes in each of 600 to 1200 zones of the presupernova star, including the effects of time dependent convection. Here each star is exploded using a piston to give a specified final kinetic energy at infinity (typically 1.2×10^{51} erg), and the explosive modifications to the nucleosynthesis, including the effects of neutrino irradiation, determined. A single value of the critical $^{12}C(\alpha,\gamma)^{16}O$ reaction rate corresponding to S(300 keV) = 170 keV barns is used in all calculations. The synthesis of each isotope is discussed along with its sensitivity to model parameters. In each case, the final mass of the collapsed remnant is also determined and often found not to correspond to the location of the piston (typically the edge of the iron core), but to a "mass cut" farther out. This mass cut is sensitive not only to the explosion energy, but also to the presupernova structure, stellar mass, and the metallicity. Unless the explosion mechanism, for unknown reasons, provides a much larger characteristic energy in more massive stars, it appears likely that stars larger than about 30 M. will experience considerable reimplosion of heavy elements following the initial launch of a successful shock. While such explosions will produce a viable, bright Type II supernova light curve, lacking the radioactive tail, they will have

dramatically reduced yields of heavy elements and may leave black hole remnants of up to 10 and more solar masses.

30908 (UCRL-JC–119957) **Ball lens reflections by direct solution of Maxwell's equations.** Ratowsky, R.P. (and others); Deri, R.J.; Kallman, J.S. Lawrence Livermore National Lab., CA (United States). 15 Feb 1995. 5p. Sponsored by USDOE, Washington, DC (United States). DOE Contract W-7405-ENG-48. (CONF-9502120–1: Integrated photonics researach conference, Dana Point, CA (United States), 23-25 Feb 1995). Order Number DE96000347. Source: OSTI; NTIS; GPO Dep.

Ball lenses are important for many applications. For example, ball lenses can be used to match the mode of a laser diode (LD) to a single mode fiber (SMF), essential for low-loss, high bit rate communication systems. Modeling the propagation of LD light through a ball lens presents a challenge due to the large angular divergence of the LD field (typically $> 20°$ HWHM) and the subsequent significant effect of spherical aberration. Accurately calculating the reflected power is also difficult, but essential, since reflections as small as –30 dB can destabilize the LID. A full-wave analysis of this system using, e.g., a finite-difference time-domain method is not practical because of the size of the ball lens, typically hundreds of wavelengths in diameter. Approximate scalar methods can give good results in some cases, but fail to calculate reflected power and miss polarization effects entirely. The authors' approach exploits the fact that the scattering of an arbitrary electromagnetic beam from a sphere is an exactly solvable problem. The scattering of a plane wave from a sphere is a classical problem which was solved by Mie in 1908. More recently, various workers have considered the scattering of a Gaussian beam from a sphere and its numerical implementation for other applications. To the authors knowledge, this is the first time this approach has been applied to a problem in optical design. They are able to calculate reflection and transmission accurately with modest computational effort.

30909 (UCRL-JC–120092) **Variational structure of inverse problems in wave propagation and vibration.** Berryman, J.G. Lawrence Livermore National Lab., CA (United States). Mar 1995. 22p. Sponsored by USDOE, Washington, DC (United States). DOE Contract W-7405-ENG-48. (CONF-950339–1: IMA workshop on inverse problems in wave propagation, Minneapolis, MN (United States), 6-17 Mar 1995). Order Number DE95011723. Source: OSTI; NTIS; GPO Dep.

Practical algorithms for solving realistic inverse problems may often be viewed as problems in nonlinear programming with the data serving as constraints. Such problems are most easily analyzed when it is possible to segment the solution space into regions that are feasible (satisfying all the known constraints) and infeasible (violating some of the constraints). Then, if the feasible set is convex or at least compact, the solution to the problem will normally lie on the boundary of the feasible set. A nonlinear program may seek the solution by systematically exploring the boundary while satisfying progressively more constraints. Examples of inverse problems in wave propagation (traveltime tomography) and vibration (modal analysis) will be presented to illustrate how the variational structure of these problems may be used to create nonlinear programs using implicit variational constraints.

30910 (UCRL-JC–120968) **Variable stars in the MACHO Collaboration database.** Cook, K.H. (Lawrence Livermore National Lab., CA (United States)); Alcock, C.; Allsman, R.A. Lawrence Livermore National Lab., CA (United States). Feb 1995. 12p. Sponsored by USDOE, Washington, DC (United States);National Science Foundation, Washington, DC (United States). DOE Contract W-7405-ENG-48. Agreement AST-8809616. (CONF-950278–2: Astrophysical applications of stellar pulsation, Cape Town (South Africa), 6-10 Feb 1995). Order Number DE95015127. Source: OSTI; NTIS; GPO Dep.

The MACHO Collaboration's search for baryonic dark matter via its gravitational microlensing signature has generated a massive database of time ordered photometry of millions Of stars in the LMC and the bulge of the Milky Way. The search's experimental design and capabilities are reviewed and the dark matter results are briefly noted. Preliminary analysis of the $\sim$ 39,000 variable stars discovered in the LMC database is presented and examples of periodic variables are shown. A class of aperiodically variable Be stars is described which is the closest background to microlensing which has been found. Plans for future work on variable stars using the MACHO data are described.

30911 (UCRL-JC–121090) **Extreme ultraviolet spectroscopy of the Seyfert 1 galaxy Markarian 478.** Liedahl, D.A. (Lawrence Livermore National Lab., CA (United States)); Paerels, F.; Hur, M.Y.; Kahn, S.M.; Fruscione, A.; Bowyer, S. Lawrence Livermore National Lab., CA (United States). 26 Jun 1995. 5p. Sponsored by USDOE, Washington, DC (United States). DOE Contract W-7405-ENG-48. (CONF-9503167–2: 1995 International Astronomical Union (IAU) colloquium #152 on astrophysics in the extreme ultraviolet, Berkeley, CA (United States), 27-30 Mar 1995). Order Number DE95016618. Source: OSTI; NTIS; GPO Dep.

The Seyfert 1 galaxy Mrk 478, observed during the EUVE all-sky survey, is the brightest EUV source among its class. The SW spectrum of this object shows evidence of discrete emission, although this interpretation is tentative, since the source spectrum must be extracted against a bright background. If the EUV flux is, in fact, composed partly of line emission, the authors attribute the discrete structure to emission from a collision-driven plasma at temperatures $\gtrsim 10^6$ K. In this context, they discuss some of the constraints imposed on the emission-line region by this observation.

30912 (UCRL-JC–121119) **A sodium guide star laser system for the Lick Observatory 3 meter telescope.** Friedman, H.W.; Erbert, G.V.; Gavel, D.T.; Kuklo, T.C.; Malik, J.G.; Salmon, J.T.; Smauley, D.A.; Thompson, G.R.; Wong, J.N. Lawrence Livermore National Lab., CA (United States). 25 May 1995. 6p. Sponsored by USDOE, Washington, DC (United States). DOE Contract W-7405-ENG-48. (CONF-9510218–1: Optical Society of America adaptive optics conference, Garching (Germany), 2-6 Oct 1995). Order Number DE96000682. Source: OSTI; NTIS; GPO Dep.

The design, installation and performance data of a 20 W pulsed laser system for the 3 meter Shane telescope at the Lick Observatory is presented.

30913 (UCRL-JC–121517) **Sonoluminescence, shock waves, and micro-thermonuclear fusion.** Moss, W.C.; Clarke, D.B.; White, J.W.; Young, D.A. Lawrence Livermore National Lab., CA (United States). Aug 1995. 8p. Sponsored by USDOE, Washington, DC (United States). DOE Contract W-7405-ENG-48. (CONF-950846–39: American Physical Society biennial conference on shock compression of condensed matter, Seattle, WA (United States), 13-18 Aug 1995). Order Number DE95017271. Source: OSTI; NTIS; INIS; GPO Dep.

We have performed numerical hydrodynamic simulations of the growth and collapse of a sonoluminescing bubble in a liquid. Our calculations show that spherically converging shock waves are generated during the collapse of the bubble. The combination of the shock waves and a realistic equation of state for the gas in the bubble provides an explanation for the measured picosecond optical pulse widths and indicates that the temperatures near the center of the bubble may exceed 3O eV. This leads naturally to speculation about obtaining micro-thermonuclear fusion in a bubble filled with deuterium (D_2) gas. Consequently, we performed numerical simulations of the collapse of a D_2 bubble in D_20. A pressure spike added to the periodic driving amplitude creates temperatures that may be sufficient to generate a very small, but measurable number of thermonuclear D-D fusion reactions in the bubble.

30914 (UCRL-JC–121670) **Performance predictions for the Keck telescope adaptive optics system.** Gavel, D.T.; Olivier, S.S. Lawrence Livermore National Lab., CA (United States). 7 Aug 1995. 10p. Sponsored by USDOE, Washington, DC (United States). DOE Contract W-7405-ENG-48. (CONF-950793–43: 40. annual meeting of the Society of Photo-Optical Instrumentation Engineers, San Diego, CA (United States), 9-14 Jul 1995). Order Number DE96000385. Source: OSTI; NTIS; GPO Dep.

The second Keck ten meter telescope (Keck-11) is slated to have an infrared-optimized adaptive optics system in the 1997–1998 time frame. This system will provide diffraction-limited images in the 1–3 micron region and the ability to use a diffraction-limited spectroscopy slit. The AO system is currently in the preliminary design phase and considerable analysis has been performed in order

to predict its performance under various seeing conditions. In particular we have investigated the point-spread function, energy through a spectroscopy slit, crowded field contrast, object limiting magnitude, field of view, and sky coverage with natural and laser guide stars.

30915 (UCRL-JC–121827) **EUVE observations of VW Hydri in superoutburst.** Mauche, C.W. Lawrence Livermore National Lab., CA (United States). Aug 1995. 4p. Sponsored by USDOE, Washington, DC (United States). DOE Contract W-7405-ENG-48. (CONF-9506270–1: IAU colloquium No. 158: cataclysmic variables and related objects, Keele (United Kingdom), 26-30 Jun 1995). Order Number DE96000420. Source: OSTI; NTIS; GPO Dep.

EUVE observed the SU UMa-type dwarf nova VW Hydri in superoutburst for an interval of nearly 2 days in 1994 June and produced EUV light curves and the first EUV spectrum of this important CV.

6620 Physics of Elementary Particles and Fields

Refer also to citation(s) 30412, 30509, 30523

30916 (DOE/ER/03071–T1) **High energy physics research. Final technical report, 1957–1994.** Williams, H.H. Pennsylvania Univ., Philadelphia, PA (United States). [1995]. 146p. Sponsored by USDOE, Washington, DC (United States). DOE Contract AC02-76ER03071. Order Number DE96000259. Source: OSTI; NTIS; INIS; GPO Dep.

This is the final technical report to the Department of Energy on High Energy Physics at the University of Pennsylvania. It discusses research conducted in the following areas: neutrino astrophysics and cosmology; string theory; electroweak and collider physics; supergravity; cp violation and baryogenesis; particle cosmology; collider detector at Fermilab; the sudbury neutrino observatory; B-physics; particle physics in nuclei; and advanced electronics and detector development.

30917 (DOE/ER/03072–T11) **High energy physics research. Final report, October 1, 1969–December 31, 1990.** Princeton Univ., NJ (United States). Dept. of Physics. May 1995. 200p. Sponsored by USDOE, Washington, DC (United States). DOE Contract AC02-76ER03072. Order Number DE95017762. Source: OSTI; NTIS; INIS; GPO Dep.

The goal of this research was to understand the fundamental constituents of matter and their interactions. First, a brief history of the high energy research at Princeton University is presented. Next, the extensive research covered in this 21 year period is summarized. Finally, a list of all publications issued during this period is presented.

30918 (INS-J–181) **Proceedings of INS workshop 'physics of e^+e^-, $e^-\gamma$ and $\gamma\gamma$ collisions at linear accelerators'.** Hioki, Zenro (Tokushima Univ. (Japan). Inst. of Theoretical Physics); Ishii, T.; Najima, Ryuichi (eds.). Tokyo Univ., Tanashi (Japan). Inst. for Nuclear Study. May 1995. 315p. (CONF-941287–: INS workshop 'physics of e^+e^-, $e^-\gamma$ and $\gamma\gamma$ collisions at linear accelerators, Tanashi (Japan), 20-22 Dec 1994). Order Number DE96701433. Source: OSTI; NTIS; INIS.

This issue is the collection of the papers presented at the title meeting. The 29 of the presented papers are indexed individually. (J.P.N.).

30919 (INS-T–535) **The 11-th INS scientific computational programs.** Tokyo Univ., Tanashi (Japan). Inst. for Nuclear Study. Jun 1995. 66p. (In Japanese, English). Order Number DE96701434. Source: OSTI; NTIS; INIS.

This issue is the collection of the papers presented at the title meeting on high energy physics. The 6 of the presented papers are indexed individually. (J.P.N.).

6621 General Theory of Particles and Fields

Refer also to citation(s) 30855, 30858, 30970, 31014

30920 (DOE/ER/40757–003) **Can EPR non-locality be geometrical?** Ne'eman, Y. (Tel-Aviv Univ. (Israel). Raymond and Beverly Sackler Faculty of Exact Sciences); Botero, A. Texas Univ., Austin, TX (United States). Dept. of Physics. [1995]. 7p. Sponsored by USDOE, Washington, DC (United States). DOE Contract FG03-93ER40757. (CPP–93-03). Order Number DE96000408. Source: OSTI; NTIS; INIS; GPO Dep.

The presence in Quantum Mechanics of non-local correlations is one of the two fundamentally non-intuitive features of that theory. The non-local correlations themselves fall into two classes: EPR and Geometrical. The non-local characteristics of the geometrical type are well-understood and are not suspected of possibly generating acausal features, such as faster-than-light propagation of information. This has especially become true since the emergence of a geometrical treatment for the relevant gauge theories, i.e. Fiber Bundle geometry, in which the quantum non-localities are seen to correspond to pure homotopy considerations. This aspect is reviewed in section 2. Contrary-wise, from its very conception, the EPR situation was felt to be paradoxical. It has been suggested that the non-local features of EPR might also derive from geometrical considerations, like all other non-local characteristics of QM. In[7], one of the authors was able to point out several plausibility arguments for this thesis, emphasizing in particular similarities between the non-local correlations provided by any gauge field theory and those required by the preservation of the quantum numbers of the original EPR state-vector, throughout its spatially-extended mode. The derivation was, however, somewhat incomplete, especially because of the apparent difference between, on the one hand, the closed spatial loops arising in the analysis of the geometrical non-localities, from Aharonov-Bohm and Berry phases to magnetic monopoles and instantons, and on the other hand, in the EPR case, the open line drawn by the positions of the two moving decay products of the disintegrating particle. In what follows, the authors endeavor to remove this obstacle and show that as in all other QM non-localities, EPR is somehow related to closed loops, almost involving homotopy considerations. They develop this view in section 3.

30921 (IC–95/57) **(0,2) string compactifications: The Higgs mechanism.** International Centre for Theoretical Physics, Trieste (Italy). Jun 1995. 19p. Order Number DE96602186. Source: OSTI; NTIS (US Sales Only); INIS.

We present the Higgs mechanism in (0,2) compactifications. The existence of a vector bundle data duality (VBDD) in (0,2) compactifications which is present at the Landau-Ginzburg point allows us to connect in a smooth manner theories with different gauge groups with the same base manifold and same number of effective generations. As we move along the Khaler moduli space of the theories with E_6 gauge group, some of the gauginos pick up masses and break the gauge group to SO(10) or SU(5). (author). 12 refs.

30922 (IC–95/74) **Canonical approach to the quantum WZNW model.** Furlan, P. (Trieste Univ., Trieste (Italy). Dipt. di Fisica); Hadjiivanov, L.K.; Todorov, I.T. International Centre for Theoretical Physics, Trieste (Italy). May 1995. 25p. Order Number DE96602187. Source: OSTI; NTIS (US Sales Only); INIS.

The canonical approach to the chiral SU(n) WZNW model with a monodromy independent r-matrix is reviewed. Taking the quantum group symmetry of the model (which reflects its classical Poisson-Lie symmetry) as a guiding principle, we derive a complete set of exchange relations in the enlarged chiral phase space that includes the Borel components $M_{\pm}$ of the monodromy matrix. Regarded as new dynamical variables the elements of M in the left and right sectors cannot be identified: their Poisson brackets have opposite signs. This is a technical reason why the canonical reduction of the pair of chiral models to a single 2-dimensional theory that involves the left and right movers' fields does not respect the quantum group symmetry. A simple modification of the Poisson brackets which does lead to an $SL_q(n)$ invariant model is proven unacceptable as a substitute for the 2D theory. As a way out we suggest a weak form of the monodromy and quantum group invariance of the extended 2D theory (involving mean values in a physical subspace of the tensor product of chiral state spaces). 34 refs.

30923 (IC–95/108) **The ergodicity of the two dimensional systems.** Baleanu, D. (International Centre for Theoretical Physics, Trieste (Italy)); Comisel, H. International Centre for Theoretical Physics, Trieste (Italy). Jun 1995. 8p. Order Number DE96602809. Source: OSTI; NTIS (US Sales Only); INIS.

Using Anosov's theorem the ergodicity properties of the two-dimensional system are investigated. (author). 14 refs, 2 figs, 1 tab.

30924 (IC–95/109) **The possible role of symmetry in physics and cosmology (a contribution to platonism).** Budinich, P. International Centre for Theoretical Physics, Trieste (Italy). Jun 1995. 22p. (ILAS/FM–13/1995.). Order Number DE96602196. Source: OSTI; NTIS (US Sales Only); INIS.

After a short review of the main concepts of the theory of continuous groups of transformations, the role of Lorentz and Poincare groups in the discovery of the relativistic revolution and of Minkowski space-time is presented. The properties of the conformal group and its possible connection with the cosmological principle are discussed. A short description of recently discovered large scale structures of distant galaxies in the universe and their interpretation as spontaneous violation of the conformal group of symmetry, or of the cosmological principle, and their analogy with the geometry of the H-atom in momentum space, is given. The possibility that, if both space-time and momentum space are conformally compactified, the difficult concepts of infinity and infinitesimal might be eliminated from the tools for understanding nature, is investigated. 14 refs, 2 figs.

30925 (IC–95/111) **The Einstein-Kaehler metrics with explicit forms on a class of egg domains.** Yin Weiping. International Centre for Theoretical Physics, Trieste (Italy). Jun 1995. 8p. Order Number DE96602811. Source: OSTI; NTIS (US Sales Only); INIS.

Because of the interest in general relativity, metrics with constant Ricci curvature are of particular importance. The purpose of this note is to describe the Einstein-Kaehler metrics with -1 Ricci curvature and with singularities in explicit form for particular domains. 5 refs.

30926 (IC–95/113) **More results about differential calculi on the quantum superplane.** El Hassouni, A. (Laboratoire de Physique Theorique, Rabat (Morocco). Faculte des Sciences); Tahri, E.H.; Hassouni, Y. International Centre for Theoretical Physics, Trieste (Italy). Jun 1995. 10p. Order Number DE96602179. Source: OSTI; NTIS (US Sales Only); INIS.

Using some natural conditions less restrictive than the $GL_{q|U,s}(m/n)$-invariance, we present two possible multiparametric differential calculi on the quantum superplane. We show that there exists a new differential calculus which is different from the known one generalizing, to the superspace case, the Wess-Zumino formalism. We discuss some *-algebra structures leaving invariant this differential calculus. The (1+1) dimensional case is analysed and a realization of the super-Virasoro algebra on this particular quantum superspace is given. (author). 12 refs.

30927 (IC–95/114) **On the realization of the deformed centreless Virasoro algebra on the quantum plane.** El Hassouni, A. (Laboratoire de Physique Theorique, Rabat (Morocco). Faculte de Sciences); Tahri, E.H.; Zakkari, M.; Hassouni, Y. International Centre for Theoretical Physics, Trieste (Italy). Jun 1995. 8p. Order Number DE96602180. Source: OSTI; NTIS (US Sales Only); INIS.

By using two types of differential structures on the quantum plane, we give two different ways to realize the deformed centreless Virasoro algebra. (author). 10 refs.

30928 (IC–95/131) **Theory of a charged spinning particle in an electromagnetic field on Taub-NUT space-time.** Baleanu, D. International Centre for Theoretical Physics, Trieste (Italy). Jun 1995. 10p. Order Number DE96602176. Source: OSTI; NTIS (US Sales Only); INIS.

The geodesic motion of pseudo-classical spinning particles in the Taub-NUT space-time, in the presence of an electromagnetic background is investigated. The 'non generic symmetries' is investigated in this case. The motion on a cone and on plane is analyzed for a particular form of $F_{\mu\nu}$. (author). 18 refs.

30929 (IC–95/135) **Spinning particles in Taub-NUT space-time.** Baleanu, D. International Centre for Theoretical Physics, Trieste (Italy). Jun 1995. 9p. Order Number DE96602177. Source: OSTI; NTIS (US Sales Only); INIS.

The geodesic motion of pseudo-classical spinning particles in the Taub-NUT space is investigated. The generalized equations for spinning space are investigated and the constants of motion are derived in terms of the solutions of these equations. The motion on a cone is analyzed. The results have applications when we investigate the electromagnetic fields in a homogeneous, nonisotropic universe. (author). 19 refs.

30930 (IC–95/136) **N=1 super-Chern-Simons coupled to parity-preserving matter from Atiyah-Ward space-time.** Andrade, M.A. de (Department of Field Theory and Particles, Rio de Janeiro (Brazil). Brazilian Centre for Research in Physics); Cima, O.M. del; Colatto, L.P. International Centre for Theoretical Physics, Trieste (Italy). Jun 1995. 10p. Order Number DE96602182. Source: OSTI; NTIS (US Sales Only); INIS.

In this letter, we present the Parkes-Siegel formulation for the massive Abelian N=1 super-QED_{2+2} coupled to a self-dual supermultiplet, by introducing a chiral multiplier superfield. We show that after carrying out a suitable dimensional reduction from (2+2) to (1+2) dimensions, and performing some necessary truncations, the simple supersymmetric extension of the $\tau_3 QED_{1+2}$ coupled to a Chern-Simons term naturally comes out. (author). 15 refs.

30931 (IC–95/138) **Normal modes of a rotating, charged and uniformly accelerated frame.** Ahmed, M. International Centre for Theoretical Physics, Trieste (Italy). Jul 1995. 5p. Order Number DE96602183. Source: OSTI; NTIS (US Sales Only); INIS.

The method for calculation of normal modes of black holes has been extended to a rotating charged and uniformly accelerated frame. The method not only extends the earlier methods in the case of black holes but also provides a way to calculate the normal modes of the black holes which are interesting from the point of view of inflationary scenario of the early universe. The method could also be interesting for calculating the normal modes of many interesting spacetimes such as Kasner and NUT spacetimes which are considered as anisotropic model in the early universe. (author). 28 refs.

30932 (IC–95/150) **Yang-Mills theory in the light-cone gauge with Lagrange multiplier field.** Tarafder, S.A.; Mansur Chowdhury, M.A. International Centre for Theoretical Physics, Trieste (Italy). Jul 1995. 8p. Order Number DE96602812. Source: OSTI; NTIS (US Sales Only); INIS.

To study the renormalizability of Yang-Mills theory in non-covariant gauges we have quantized the theory using Lagrange multiplier field method. The one-loop vacuum polarization of pure Yang-Mills theory have been evaluated using light-cone gauge. It has been shown that the one-loop tensor is not only transverse but also gauge independent and local. It reveals that we can renormalize the theory by adding only finite number of counter terms. (author). 17 refs, 2 figs.

30933 (IC–95/151) **Nonreductive WZW models and their CFTs.** Figueroa O'Farrill, J.M. (Queen Mary Coll., London (United Kingdom). Dept. of Physics); Stanciu, S. International Centre for Theoretical Physics, Trieste (Italy). Jul 1995. 33p. (QMW-PH–95-17; Hep-th–9506151). Order Number DE96602184. Source: OSTI; NTIS (US Sales Only); INIS.

We study two-dimensional WZW models with target space a nonreductive Lie group. Such models exist whenever the Lie group possess a bi-invariant metric. We show that such WZW models provide a Lagrangian description of the nonreductive (affine) Sugawara construction. We investigate the gauged WZW models and we prove that gauging a diagonal subgroup results in a conformal field theory which can be identified with a coset construction. A large class of exact four-dimensional string backgrounds arise in this fashion. We then study the topological conformal field theory resulting from the G/G coset. We identify the Kazama algebra extending the BRST algebra, and the BV algebra structure in BRST cohomology which it induces. (author). 34 refs.

30934 (IC–95/152) **On the structure of symmetric self-dual Lie algebras.** Figueroa O'Farrill, J.M. (Queen Mary Coll., London (United Kingdom). Dept. of Physics); Stanciu, S. International Centre for Theoretical Physics, Trieste (Italy). Jul 1995. 19p. (QMW-PH–95-24; Hep-th–9506152). Order Number DE96602185. Source: OSTI; NTIS (US Sales Only); INIS.

A finite-dimensional Lie algebra is called (symmetric) self-dual, if it possesses an invariant nondegenerate (symmetric) bilinear form. Symmetric self-dual Lie algebras have been studied by Medina and Revoy, who have proven a very useful theorem about their structure. In this paper we prove a refinement of their theorem which has wide applicability in Conformal Field Theory, where symmetric self-dual Lie algebras start to play an important role due to the fact they are precisely the Lie algebras which admit a Sugawara construction. We also prove a few corollaries which are important in Conformal Field Theory. (author). 11 refs.

30935 (IC–95/171) **CP violation from spin-1/2 constituents of the weak bosons.** Lemke, E.H. International Centre for Theoretical Physics, Trieste (Italy). Jul 1995. 19p. Order Number DE96602818. Source: OSTI; NTIS (US Sales Only); INIS.

Spin 1 can be represented by a mixed rank-2 spinor of the Lorentz group, which gives rise to the option of interpreting the particles W and Z as compounds of two spin-1/2 constituents. We analyze the scenario characterized by the absence of non-local structures in the interaction couplings at low energies. It seems to be possible to achieve a self-contained description. The existence of an isoscalar vector particle (Y) is predicted and it is shown that all its couplings can be understood by wave functions that are independent of the assignment of electric charge to the two spin-1/2 constituents. The vertices, in particular those including γ, Z, Y and W, possess the feature of hermicity. The emission of Y by W and Z will violate CP. We get agreement with the experimental absence of electric dipole moments of the electron and neutron and find substantial contributions to the CP impurity parameter of indirect CP violation in the K^0-K-bar^0 system. These contributions represent two-loop effects. Moreover, the precise form of a trilinear vertex for the neutral-current production of Z pairs is predicted. It can be tested at LEP II. (author). 11 refs, 4 figs.

30936 (IC–95/172) **Generation of $128h^{-1}$ Mpc periodicity of the universe in the scalar field condensate baryogenesis scenario.** Chizhov, M.V.; Kirilova, D.P. International Centre for Theoretical Physics, Trieste (Italy). Jul 1995. 8p. Order Number DE96602810. Source: OSTI; NTIS (US Sales Only); INIS.

A mechanism for generating baryon density perturbations in the scalar field condensate baryogenesis scenario is proposed. Both the observed baryon asymmetry and the observed periodicity in the large scale structure of the Universe with the characteristic scale of $128h^{-1}$Mpc can be explained as due to the evolution of a complex scalar field condensate formed at the inflationary stage. (author). 13 refs, 2 figs.

30937 (IFVE-OTF–94-64) **Electromagnetic interaction in the theory of straight-line string.** Nikitin, I.N.; Pron'ko, G.P. Gosudarstvennyj Komitet po Ispol'zovaniyu Atomnoj Ehnergii SSSR, Serpukhov (Russian Federation). Inst. Fiziki Vysokikh Ehnergij. 1994. 30p. (In Russian). Order Number DE96602188. Source: OSTI; NTIS (US Sales Only); INIS.

Submitted to Yadernaya Fizika.

A scheme of electromagnetic interaction inclusion into theories of extended relativistic objects is proposed. In the theory of straight-line string an operator of electromagnetic interaction is constructed and form factors of electromagnetic transitions are calculated. 6 refs.; 1 fig.

30938 (INIS-BR–3540, pp. 1-23) **Fixing the gauge at future null infinity.** Moreschi, O.M. (Cordoba Univ. Nacional (Argentina). Facultad de Matematicas, Astronomia y Fisica). Sociedade Brasileira de Fisica, Sao Paulo, SP (Brazil). 1993. 251p. (CONF-9109557–: 12. national meeting on particle physics and fields, Caxambu (Brazil), 18-22 Sep 1991). In *Proceedings of the 12. National Meeting on Particle Physics and Fields.* Order Number DE96602594. Source: OSTI; NTIS; INIS.

After a review of fundamental concepts around the notion of isolated systems in curved spacetimes, we analyse the problem of the ambiguities of the super translations at future null infinity. We propose a tool that provides a clean way to fix the gauge problem; namely the notion of nice sections. We conclude with some resent results on nice sections on a particular class of radiant spacetimes. (author). 19 refs.

30939 (INIS-BR–3540, pp. 24-35) **Finiteness in gauge field theories.** Sorella, S.P. (Universidade Catolica de Petropolis, RJ (Brazil)). Sociedade Brasileira de Fisica, Sao Paulo, SP (Brazil). 1993. 251p. (CONF-9109557–: 12. national meeting on particle physics and fields, Caxambu (Brazil), 18-22 Sep 1991). In *Proceedings of the 12. National Meeting on Particle Physics and Fields.* Order Number DE96602594. Source: OSTI; NTIS; INIS.

Finiteness properties of gauge field theories are discussed by means of a functional differential equation which holds in the Landau-gauge and which allows to establish the non-renormalization of the ghost field and of the composite operator. (trc^3). (author). 10 refs, 1 tab.

30940 (INIS-BR–3540, pp. 48-51) **Topological effects due to a cosmic string.** Bezerra, V.B. (Paraiba Univ., Joao Pessoa, PB (Brazil). Dept. de Fisica); Santos, I.B. dos. Sociedade Brasileira de Fisica, Sao Paulo, SP (Brazil). 1993. 251p. (CONF-9109557–: 12. national meeting on particle physics and fields, Caxambu (Brazil), 18-22 Sep 1991). In *Proceedings of the 12. National Meeting on Particle Physics and Fields.* Order Number DE96602594. Source: OSTI; NTIS; INIS.

Some effects of global features of the spacetime of a straight cosmic string on quantum particles are studied, using the Klein-Gordon and Dirac equations in covariant forms. (M.C.K.). 12 refs.

30941 (INIS-BR–3540, pp. 75-78) **On the three-dimensional Dirac equation.** Linhares, C.A. (Centro Tecnico Aeroespacial (CTA-IEAv), Sao Jose dos Campos, SP (Brazil). Inst. de Estudos Avancados); Mignaco, J.A. Sociedade Brasileira de Fisica, Sao Paulo, SP (Brazil). 1993. 251p. (In Portuguese). (CONF-9109557–: 12. national meeting on particle physics and fields, Caxambu (Brazil), 18-22 Sep 1991). In *Proceedings of the 12. National Meeting on Particle Physics and Fields.* Order Number DE96602594. Source: OSTI; NTIS; INIS.

It is shown that the usual Dirac matrices representation are not consistent, and do not accomplish with the conditions that the gamma matrices must fulfill. The correct description requests four-dimension Dirac matrices, with not identical diagonal blocks structure. (L.C.J.A.). 6 refs.

30942 (INIS-BR–3540, pp. 79) **The relation between Dirac equation and unitary group algebras for any dimension of space-time.** Linhares, C.A. (Centro Tecnico Aeroespacial (CTA-IEAv), Sao Jose dos Campos, SP (Brazil). Inst. de Estudos Avancados); Mignaco, J.A. Sociedade Brasileira de Fisica, Sao Paulo, SP (Brazil). 1993. 251p. (In Portuguese). (CONF-9109557–: 12. national meeting on particle physics and fields, Caxambu (Brazil), 18-22 Sep 1991). In *Proceedings of the 12. National Meeting on Particle Physics and Fields.* Order Number DE96602594. Source: OSTI; NTIS; INIS.

Short communication. DIRAC OPERATORS/su groups; SU GROUPS/dirac operators; DIMENSIONS; SPACE-TIME; UNITARY SYMMETRY

30943 (INIS-BR–3540, pp. 99-102) **Non vibrating and vibrating skyrmions.** Herscovitz, V.E. (Rio Grande do Sul Univ., Porto Alegre, RS (Brazil). Inst. de Fisica); Steffens, F.M. Sociedade Brasileira de Fisica, Sao Paulo, SP (Brazil). 1993. 251p. (In Portuguese). (CONF-9109557–: 12. national meeting on particle physics and fields, Caxambu (Brazil), 18-22 Sep 1991). In *Proceedings of the 12. National Meeting on Particle Physics and Fields.* Order Number DE96602594. Source: OSTI; NTIS; INIS.

The instability of the static solution of nonlinear γ model lead Skyrme to add quark interaction in the Lagrangian. The obtainment of solitonic solutions for nonlinear γ model is still analysed with proposals for vibrating freedom degree quantization. Some Hamiltonians of these formulations considering symmetric quark interaction within generalization of Skyrme model are compared. (M.C.K.). 16 refs.

30944 (INIS-BR–3540, pp. 130-135) **Higher spin symmetries of whole affinity conformal model.** Aratyn, H. (Instituto de Fisica Teorica (IFT), Sao Paulo, SP (Brazil)); Constantinidis, C.P.; Ferreira, L.A.; Gomes, J.F.; Zimerman, A.H. Sociedade Brasileira de Fisica, Sao Paulo, SP (Brazil). 1993. 251p. (In Portuguese). (CONF-9109557–: 12. national meeting on particle physics and

fields, Caxambu (Brazil), 18-22 Sep 1991). In *Proceedings of the 12. National Meeting on Particle Physics and Fields.* Order Number DE96602594. Source: OSTI; NTIS; INIS.

The integrable models which present conformal invariance are studied, and observing algebraic structures to obtain a relation between their properties. The construction of algebraic structure for charges of whole affinity conformal model is proposed to analyse symmetries. (M.C.K.). 5 refs.

30945 (INIS-BR–3540, pp. 136-139) **Quantum string scattering in shock waves backgrounds.** Costa, M.E.V. (Rio Grande do Sul Univ., Porto Alegre, RS (Brazil). Inst. de Fisica); Vega, H.J. de. Sociedade Brasileira de Fisica, Sao Paulo, SP (Brazil). 1993. 251p. (CONF-9109557–: 12. national meeting on particle physics and fields, Caxambu (Brazil), 18-22 Sep 1991). In *Proceedings of the 12. National Meeting on Particle Physics and Fields.* Order Number DE96602594. Source: OSTI; NTIS; INIS.

The scattering of particles by a gravitational shock wave in the framework of string theory is investigated. The shock wave described by the Aichelburg-Sexl metric (that is the gravitational field of a neutral spinless ultrarelativistic particle) is relevant to particle scattering at Planck energy. Base on this, the scattering of a string (in one of its stationary states) by a particle with an energy of the order or larger than the Planck mass was studied. The string is considered as a test string, in other words, its energy must be much smaller than the energy carried by the shock wave. (M.C.K.). 12 refs.

30946 (INIS-BR–3540, pp. 140-143) **Correlation function and mass spectrum of quantum vortices.** Ramos, R.O. (Sao Paulo Univ., SP (Brazil). Inst. de Fisica); Marques, G.C.; Marino, E.C.; Ruiz, J.S. Sociedade Brasileira de Fisica, Sao Paulo, SP (Brazil). 1993. 251p. (CONF-9109557–: 12. national meeting on particle physics and fields, Caxambu (Brazil), 18-22 Sep 1991). In *Proceedings of the 12. National Meeting on Particle Physics and Fields.* Order Number DE96602594. Source: OSTI; NTIS; INIS.

The method of soliton quantization is used to obtain explicit expressions for the vortex mass spectrum and the asymptotic behaviour of vortex correlation function in the Abelian Higgs Model in 2+1 D. (author). 6 refs.

30947 (INIS-BR–3540, pp. 152-155) **Calculation of Green functions of generalized Schwinger model by functional integration method.** Souza Dutra, A. de (UNESP, Guaratingueta, SP (Brazil). Dept. de Fisica e Quimica). Sociedade Brasileira de Fisica, Sao Paulo, SP (Brazil). 1993. 251p. (In Portuguese). (CONF-9109557–: 12. national meeting on particle physics and fields, Caxambu (Brazil), 18-22 Sep 1991). In *Proceedings of the 12. National Meeting on Particle Physics and Fields.* Order Number DE96602594. Source: OSTI; NTIS; INIS.

The Green functions of non-anomalous generalized Schwinger model using diverse gauge fix by a sequence of field transformations are calculated. The regularization parameter assumes the value a= g 1. (a=1 in Chiral Schwinger model). The gauge invariance correlation functions were obtained. (M.C.K.). 4 refs.

30948 (INIS-BR–3540, pp. 156-163) **An alternative prescription for gauging Floreanini-Jackiw chiral bosons.** Dias, S.A. (Centro Brasileiro de Pesquisas Fisicas (CBPF), Rio de Janeiro, RJ (Brazil)); Souza Dutra, A. de. Sociedade Brasileira de Fisica, Sao Paulo, SP (Brazil). 1993. 251p. (CONF-9109557–: 12. national meeting on particle physics and fields, Caxambu (Brazil), 18-22 Sep 1991). In *Proceedings of the 12. National Meeting on Particle Physics and Fields.* Order Number DE96602594. Source: OSTI; NTIS; INIS.

We seek new couplings of chiral bosons to U(1) gauge fields. Lorentz covariance of the resulting constrained Lagrangian is checked with the help of a procedure based in the first-order formalism of Faddeev and Jackiw. We find Harada's constraint and another local one not previously considered. We analyse the constraint structure and part of the spectrum of this second solution and show that it is equivalent to an explicitly covariant coupling of Siegel's chiral boson to gauge fields, which preserves chirality under gauge transformations. (author). 13 refs.

30949 (INIS-BR–3540, pp. 164-167) **Yang-Mills/sigma model (2,0) coupling in varieties with torsion.** Almeida, C.A.S. (Ceara Univ., Fortaleza, CE (Brazil). Dept. de Fisica); Helayel Neto, J.A. Sociedade Brasileira de Fisica, Sao Paulo, SP (Brazil). 1993. 251p. (In Portuguese). (CONF-9109557–: 12. national meeting on particle physics and fields, Caxambu (Brazil), 18-22 Sep 1991). In *Proceedings of the 12. National Meeting on Particle Physics and Fields.* Order Number DE96602594. Source: OSTI; NTIS; INIS.

The coupling of Yang-Mills supermultiplet to non linear sigma model is done in the superspace (2,0), by space-target isometry gauging of sigma model considered in this case as a generic variety with torsion. (M.C.K.).

30950 (INIS-BR–3540, pp. 168-171) **The expansion of heat kernel in curved space-time at finite temperature.** Boschi Filho, H. (UNESP, Guaratingueta, SP (Brazil). Dept. de Fisica e Quimica); Natividade, C.P. Sociedade Brasileira de Fisica, Sao Paulo, SP (Brazil). 1993. 251p. (In Portuguese). (CONF-9109557–: 12. national meeting on particle physics and fields, Caxambu (Brazil), 18-22 Sep 1991). In *Proceedings of the 12. National Meeting on Particle Physics and Fields.* Order Number DE96602594. Source: OSTI; NTIS; INIS.

The expansion of heat Kernel in curve space-time at finite temperature is used to calculate chiral and trace anomalous. (M.C.K.) 14 refs.

30951 (INIS-BR–3540, pp. 214-217) **Non-anomalous bosonized theories from a gauge principle.** Souza Dutra, A. de (UNESP, Guaratingueta, SP (Brazil). Faculdade de Engenharia). Sociedade Brasileira de Fisica, Sao Paulo, SP (Brazil). 1993. 251p. (CONF-9109557–: 12. national meeting on particle physics and fields, Caxambu (Brazil), 18-22 Sep 1991). In *Proceedings of the 12. National Meeting on Particle Physics and Fields.* Order Number DE96602594. Source: OSTI; NTIS; INIS.

Starting from a gauge principle for a scalar boson we show that one can get, in 1 + 1 dimensions, the Lagrangian density of the generalized Schwinger model (GSM) in its bosonized version. This occur for a particular value of the regularization parameter. When we show how to get the model with the arbitrary parameter through the introduction of the Wess-Zumino field. (author). 6 refs.

30952 (INIS-BR–3540, pp. 226-229) **Algebraic calculation of propagators in curved spaces.** Rabello, S.J. (Universidade Federal, Rio de Janeiro, RJ (Brazil). Inst. de Fisica); Vaidya, A.N. Sociedade Brasileira de Fisica, Sao Paulo, SP (Brazil). 1993. 251p. (In Portuguese). (CONF-9109557–: 12. national meeting on particle physics and fields, Caxambu (Brazil), 18-22 Sep 1991). In *Proceedings of the 12. National Meeting on Particle Physics and Fields.* Order Number DE96602594. Source: OSTI; NTIS; INIS.

Using Schwinger representation, BCH formula and SO(2,1) Lie Group, Green functions of scalar field in some cosmological models, were obtained. (M.C.K.). 6 refs.

30953 (INIS-BR–3540, pp. 234-238) **Quantum corrections to classical solutions.** Baltar, V.L.V. (Pontificia Univ. Catolica do Rio de Janeiro, RJ (Brazil). Dept. de Fisica); Llambias, J.; Masperi, L. Sociedade Brasileira de Fisica, Sao Paulo, SP (Brazil). 1993. 251p. (CONF-9109557–: 12. national meeting on particle physics and fields, Caxambu (Brazil), 18-22 Sep 1991). In *Proceedings of the 12. National Meeting on Particle Physics and Fields.* Order Number DE96602594. Source: OSTI; NTIS; INIS.

In a real scalar field model in 1 + 1 dimensions with quartic and sixtic selfcoupling there appears a classically unstable nontopological soliton which, in a certain parameter range of the model, is stabilized by quantum corrections. (author). 8 refs.

30954 (LA-UR–95-2101) **Searches for T-odd interactions in nuclear processes: Review of the theory.** Herczeg, P. Los Alamos National Lab., NM (United States). [1995]. 12p. Sponsored by USDOE, Washington, DC (United States). DOE Contract W-7405-ENG-36. (CONF-950183–4: Recontres de Moriond workshop, Villar-sur-Ollon (Switzerland), 21-28 Jan 1995). Order Number DE95016874. Source: OSTI; NTIS; INIS; GPO Dep.

CP-violation has been seen so far only in the neutral kaon system. Its origin is still unknown. If the CPT theorem holds, as is the case in gauge theories, CP-violating interactions violate also time

reversal (T) invariance. Regarding the CPT theorem there is some experimental evidence that the interaction responsible for the observed CP-violation violates T-invariance. The observed CP-violation may just be a manifestation of the weak interaction of the Standard Model (SM), or it is due to an interaction beyond the SM. In both cases some of the new interactions may give rise to observable CP-violation where the SM contribution is invisible. This underlines the importance of searching for CP-violating and T-violating effects in many processes. In this talk we shall review what has been learned about T-violating interactions that can be probed in nuclear processes from experiments outside of and within nuclear physics, and consider the role of nuclear physics experiments in obtaining further information on such interactions.

30955 (LA-UR–95-2894) **Quark model calculations of symmetry breaking in parton distributions.** Benesh, C.J.; Goldman, J.T.; Stephenson, G.J. Los Alamos National Lab., NM (United States). [1995]. 6p. Sponsored by USDOE, Washington, DC (United States). DOE Contract W-7405-ENG-36. (CONF-9505280–3: International symposium on particle theory and phenomenology, Ames, IA (United States), 22-24 May 1995). Order Number DE96000002. Source: OSTI; NTIS; INIS; GPO Dep.

Using a quark model, we calculate symmetry breaking effects in the valence quark distributions of the nucleon. In particular, we examine the breaking of the quark model SU(4) symmetry by color magnetic effects, and find that color magnetism provides an explanation for deviation of the ratio $d_v(x)/u_v(x)$ from 1/2. Additionally, we calculate the effect of charge symmetry breaking in the valence quark distributions of the proton and neutron and find, in contrast to other authors, that the effect is too small to be seen experimentally.

30956 (LBL–37565) **Applications of flavor symmetry to the phenomenology of elementary particles.** Kaeding, T.A. (Lawrence Berkeley Lab., CA (United States)). Lawrence Berkeley Lab., CA (United States); California Univ., Berkeley, CA (United States). May 1995. 98p. Sponsored by USDOE, Washington, DC (United States). DOE Contract AC03-76SF00098. Order Number DE96001059. Source: OSTI; NTIS; INIS; GPO Dep.

Some applications of flavor symmetry are examined. Approximate flavor symmetries and their consequences in the MSSM (Minimal Supersymmetric Standard Model) are considered, and found to give natural values for the possible B- and L-violating couplings that are empirically acceptable, except for the case of proton decay. The coupling constants of SU(3) are calculated and used to parameterize the decays of the D mesons in broken flavor SU(3). The resulting couplings are used to estimate the long-distance contributions to D-meson mixing.

30957 (SLAC-PUB–95-6934) **Supersymmetry in the very early universe.** Thomas, S. Stanford Univ., CA (United States). Jun 1995. 6p. Sponsored by USDOE, Washington, DC (United States). DOE Contract AC03-76SF00515. (CONF-9503183–1: Joint meeting of the international symposium on particles, strings and cosmology, and the 19. Johns Hopkins workshop in current problems in particle theory, Baltimore, MD (United States), 22-25 Mar 1995). Order Number DE95017725. Source: OSTI; NTIS; INIS; GPO Dep.

Supersymmetric flat directions can have a number of important consequences in the very early universe. Depending on the form of the SUSY breaking potential arising from the finite energy density at early times, coherent production of scalar condensates can result along such directions. This leads a cosmological disaster for Polonyi type flat directions with only Planck suppressed couplings, but can give rise to the baryon asymmetry for standard model flat directions. Flat directions are also natural candidates to act as inflatons. Achieving density fluctuations of the correct magnitude generally requires an additional hidden SUSY breaking sector.

30958 (UCRL-JC–121831) **Enigmatic electrons, photons, and "empty" waves.** MacGregor, M.H. Lawrence Livermore National Lab., CA (United States). 22 Aug 1995. 12p. Sponsored by USDOE, Washington, DC (United States). DOE Contract W-7405-ENG-48. (CONF-9508171–1: The present status of the quantum theory of light: a symposium to honor Jean-Piere Vigier, Toronto (Canada), 27-30 Aug 1995). Order Number DE96000701. Source: OSTI; NTIS; INIS; GPO Dep.

A spectroscopic analysis is made of electrons and photons from the standpoint of physical realism. In this conceptual framework, moving particles are portrayed as localized entities which are surrounded by "empty" waves. A spectroscopic model for the electron Stands as a guide for a somewhat similar, but in essential respects radically different, model for the photon. This leads in turn to a model for the "zeron". the quantum of the empty wave. The properties of these quanta mandate new basis states, and hence an extension of our customary framework for dealing with them. The zeron wave field of a photon differs in one important respect from the standard formalism for an electromagnetic wave. The vacuum state emerges as more than just a passive bystander. Its polarization properties provide wave stabilization, particle probability distributions, and orbit quantization. Questions with regard to special relativity are discussed.

30959 (UM-P–94/118) **From $m_d = m_e$ to realistic relations in quark-lepton symmetric models.** Shaw, D.S.; Volkas, R.R. Melbourne Univ., Parkville, VIC (Australia). School of Physics. [1995]. 13p. Sponsored by Australian Research Council, Canberra, ACT (Australia). (RCHEP–33.). Order Number DE96602819. Source: OSTI; NTIS; INIS.

In recent years a new potential symmetry of fundamental particle physics has been investigated - discrete quark-lepton symmetry. When this symmetry is implemented, however, it often leads to either of the unrealistic predictions $m_u = m_e$ or $m_d = m_e$. After summarizing the basic framework of quark-lepton symmetry, two ideas are discussed, based on $m_d = m_e$, by which the mass relations might lead to explanations for the major trends in the masses of the fermions within each family. 6 refs.

30960 (UM-P–94/120) **Experimental status of quaternionic quantum mechanics.** Brumby, S.P.; Joshi, G.C. Melbourne Univ., Parkville, VIC (Australia). School of Physics. [1995]. 12p. Sponsored by Australian Research Council, Canberra, ACT (Australia). (RCHEP–94/34.). Order Number DE96602813. Source: OSTI; NTIS; INIS.

Analysis of the logical foundations of quantum mechanics indicates the possibility of constructing a theory using quaternionic Hilbert spaces. Whether this mathematical structure reflects reality is a matter for experiment to decide. The only direct search for quaternionic quantum mechanics yet carried out is reviewed and is proposed to look for quaternionic effects in correlated multi-particle systems. It is also discussed how such experiments might distinguish between the several quaternionic models proposed in the literature. 21 refs.

30961 (UM-P–95/09) **An octonionic gauge theory.** Lassig, C.C.; Joshi, G.C. Melbourne Univ., Parkville, VIC (Australia). School of Physics. 19 Jan 1995. 14p. (RCHEP–95/05.). Order Number DE96602814. Source: OSTI; NTIS; INIS.

The nonassociativity of the octonion algebra makes necessitates a bimodule representation, in which each element is represented by a left and a right multiplier. This representation can then be used to generate gauge transformations for the purpose of constructing a field theory symmetric under a gauged octonion algebra, the nonassociativity of which appears as a failure of the representation to close, and hence produces new interactions in the gauge field kinetic term of the symmetric Lagrangian. 5 refs., 1 tab.

30962 (UM-P–95/12) **The Foldy-Wouthuysen transformation.** Costella, J.P.; McKellar, B.H.J. Melbourne Univ., Parkville, VIC (Australia). School of Physics. 31 Jan 1995. 6p. Sponsored by Australian Research Council, Canberra, ACT (Australia);USDOE Office of Energy Research, Washington, DC (United States). Grant DOE/ER40561. (RCHEP–95/08.). Order Number DE96602815. Source: OSTI; NTIS; INIS.

The Foldy-Wouthuysen transformation of the Dirac Hamiltonian is generally taught as simply a mathematical trick that allows one to obtain a two-component theory in the low-energy limit. It is not often emphasized that the transformed representation is the only one in which one can take a meaningful classical limit, in terms of particle and antiparticles. It is recognised that there are two representations of the Dirac equation. The Dirac-Pauli representation is

unique due to its linearity; it is the representation in which the charged leptons are minimally coupled. The Newton-Wigner representation is unique due to its decoupling of positive- and negative-energy states; it is the representation in which the operators of the theory correspond to their classical counterparts. 12 refs.

6622 Specific Theories and Interaction Models; Particle Systematics

Refer also to citation(s) 30359, 30532, 30930, 30955, 30999, 31012, 31013, 31018, 31085, 31086, 31087, 31088, 31089

30963 (FNAL/C–95/192-E) **Inclusive jet production at Tevatron.** Bhatti, A.A. CDF Collaboration; D0 Collaboration. Fermi National Accelerator Lab., Batavia, IL (United States). Jul 1995. 12p. Sponsored by USDOE, Washington, DC (United States). DOE Contract AC02-76CH03000. (CONF-9505137–9: 10. topical workshop on proton-antiproton collider physics, Batavia, IL (United States), 9-13 May 1995). Order Number DE95016698. Source: OSTI; NTIS; INIS; GPO Dep.

The CDF and D0 Collaborations have measured the inclusive jet cross section using 1992–93 collider data at $\sqrt{s}$ = 1,800 GeV. The D0 measurement is higher than NLO QCD predictions, though within systematic uncertainties. The CDF measurement is in very good agreement with NLO QCD predictions for transverse energies (E_T) below 200 GeV. However it is systemically higher than NLO QCD predictions for E_T above 200 GeV. The CDF measurement of two-jet mass and total transverse energy spectra also show a similar excess above QCD predictions at higher E_T.

30964 (FNAL/C–95/259-E) **Tests of QCD in W and Z production at Tevatron.** Abachi, S. The D0 Collaboration. Fermi National Accelerator Lab., Batavia, IL (United States). 1 Aug 1995. 25p. Sponsored by USDOE, Washington, DC (United States);National Science Foundation, Washington, DC (United States);Korea Ministry of Education (Korea);Korea Science and Engineering Foundation (Korea, Republic of);CEA, 75 - Paris (France);Ministry of Science a DOE Contract AC02-76CH03000. (CONF-950705–19: HEP 95: international Europhysics conference on high-energy physics, Brussels (Belgium), 21-27 Jul 1995). Order Number DE96000410. Source: OSTI; NTIS; INIS; GPO Dep.

We present measurements of the production cross sections times leptonic branching fractions and the transverse momentum distributions of W and Z bosons in $p\bar{p}$ collisions at $\sqrt{s}$ = 1.8 TeV using data collected with the DO detector at the Fermilab Tevatron $p\bar{p}$ collider. A preliminary measurement of the W charge asymmetry is also presented.

30965 (FNAL/C–95/277-E) **Kinematics of the $t\bar{t}$ events in W + Jets at CDF.** Beretvas, A. The CDF Collaboration. Fermi National Accelerator Lab., Batavia, IL (United States). Aug 1995. 10p. Sponsored by USDOE, Washington, DC (United States). DOE Contract AC02-76CH03000. (CONF-9505280–4: International symposium on particle theory and phenomenology, Ames, IA (United States), 22-24 May 1995). Order Number DE96000107. Source: OSTI; NTIS; INIS; GPO Dep.

We compare the CDF W + N $\geq$ 3 Jets data with predictions using the standard model. Herwig is used to simulate $t\bar{t}$ production and VECBOS is used to simulate QCD W + n $\geq$ 3 Jets. We look at four different data sets with $t\bar{t}$ content varying from 20% to 75%. We examine several kinematic variables. We conclude that the data is consistent with the standard model.

30966 (FNAL/C–212-E) **A study of the strong coupling constant using W+ jets processes.** Abachi, S. D0 Collaboration. Fermi National Accelerator Lab., Batavia, IL (United States). Jul 1995. 8p. Sponsored by USDOE, Washington, DC (United States). DOE Contract AC02-76CH03000. (CONF-950705–9: HEP 95: international Europhysics conference on high-energy physics, Brussels (Belgium), 21-27 Jul 1995). Order Number DE95016387. Source: OSTI; NTIS; INIS; GPO Dep.

The ratio of the number of W + 1 jet to W + 0 jet events is measured with the D0 detector using data from, the 1992–93 Tevatron Collider run. For the $W \rightarrow e\nu$ channel with a minimum jet E_T cutoff of 25 GeV, the experimental ratio is 0.065 $\pm$ 0.003(stat) $\pm$ 0.007(sys). Next-to-Leading order QCD predictions for various parton distributions agree well with each other and are all over one standard deviation below the measurement. Varying the strong coupling constant α_s in both the parton distributions and the partonic cross sections simultaneously does not remove this discrepancy.

30967 (IC–95/105) **A dynamical left-right symmetry breaking model.** Akhmedov, E.Kh. International Centre for Theoretical Physics, Trieste (Italy). Jun 1995. 6p. Order Number DE96602198. Source: OSTI; NTIS (US Sales Only); INIS.

Left-right symmetry breaking in a model with composite Higgs scalars is discussed. It is assumed that the low-energy degrees of freedom are just fermions and gauge bosons and that the Higgs bosons are generated dynamically through a set of gauge- and parity-invariant 4-fermion operators. It is shown that in a model with composite bi- doublet and two triplet scalars there is no parity breaking at low energies, whereas in the model with two doublets instead of two triplets parity is broken automatically regardless of the choice of the parameters of the model. For phenomenologically allowed values of the right-handed scale the tumbling symmetry breaking mechanism is realized in which parity breaking at a high scale μ_R propagates down and eventually causes the electroweak symmetry breaking at the scale $\mu_{EW} \approx$ 100 GeV. The model exhibits a number of low and intermediate mass Higgs bosons with certain relations between their masses. In particular, the $SU(2)_L$ Higgs doublet χ_L is a pseudo-Goldstone boson of the accidental (approximate) SU(4) symmetry of the Higgs potential and therefore is expected to be relatively light. (author). 5 refs.

30968 (IC–95/118) **The 331 model with right-handed neutrinos.** Hoang Ngoc Long. International Centre for Theoretical Physics, Trieste (Italy). Jun 1995. 16p. Order Number DE96602199. Source: OSTI; NTIS (US Sales Only); INIS.

The electroweak model with right-handed neutrinos is investigated in detail. By introducing a Z - Z' mixing angle ϕ, the exact physical eigenstates for neutral gauge bosons are obtained. Because of the mixing there is a modification to the Z coupling proportional to sin ϕ. The data from the Z decay allows us to fix - 0.0021 $\leq \phi \leq$ 0.000064. From neutrino neutral current scatterings, we get the range of the new neutral gauge boson Z' mass to be greater than 550 GeV. From symmetry-breaking hierarchy a bound for the new charged and neutral (non-Hermitian) gauge bosons $Y^{\pm}$, X^0 are obtained. Using the limit for the mixing angle, we get a bound for R_b: 0.219717 $\leq R_b \leq$ 0.220434, which is in good agreement with the recent result measured at LEP. (author). 25 refs, 2 tabs.

30969 (IC–95/120) **Constraints on "fixed point" QCD from the CCFR data on deep inelastic neutrino-nucleon scattering.** Sidorov, A. (Joint Inst. for Nuclear Research, Dubna (Russian Federation). Bogoliubov Theoretical Lab.); Stamenov, D.B. International Centre for Theoretical Physics, Trieste (Italy). Jun 1995. 7p. Contract NB-93-1180; Grant N-94-02-03463. Order Number DE96602205. Source: OSTI; NTIS (US Sales Only); INIS.

The results of LO Fixed point QCD (FP-QCD) analysis of the CCFR data for the nucleon structure function $xF_3(x,Q^2)$ are presented. The predictions of FP-QCD, in which $\alpha_s(Q^2)$ tends to a nonzero coupling constant α_0 as $Q^2 \rightarrow \infty$, are in good agreement with the data. Constraints for the possible values of the β function parameter b regulating how fast $\alpha_s(Q^2)$ tends to its asymptotic value α_0 are found from the data. The corresponding values of α_0 are also determined. Having in mind the recent QCD fits to the same data we conclude that in spite of the high precision and the large (x,Q^2) kinematic range of the CCFR data they cannot discriminate between QCD and FP-QCD predictions for $xF_3(x,Q^2)$. (author). 14 refs, 1 tab.

30970 (IC–95/122) **Large R-parity violating couplings and grand unification.** Smirnov, A.Yu.; Vissani, F. International Centre for Theoretical Physics, Trieste (Italy). Jun 1995. 23p. Order Number DE96602200. Source: OSTI; NTIS (US Sales Only); INIS.

We consider the possibility that R-parity violating interactions of particles from second and third matter generations have large (up to 1) coupling constants, Λ. Such couplings have a number of phenomenological consequences: renormalization of b - τ mass ratio, generation of ν_τ mass in MeV region, etc. In Grand Unified models,

where B- and L-violating couplings appear simultaneously, the proton decay can be forbidden in virtue of hierarchical flavour structure of Λ. However, due to Cabibbo-Kobayashi-Maskawa mixing, this decay is induced already in one-loop. Present experimental data give the upper bound $\Lambda <$or approx. $3 \cdot 10^{-9}$ (or modul $\lambda'\lambda'' <$or approx. $5 \cdot 10^{-17}$, on the product of the L- and B-violating coupling constants, in more general context). The bounds can be avoided, if there is an asymmetry between the L- and B-violating couplings of usual matter fields. In the SU(5) model the asymmetry can be related to the doublet-triplet splitting. (author). 26 refs, 2 figs.

30971 (IC–95/134) **Finite size corrections in Hadronic equation of state.** Singh, C.P. International Centre for Theoretical Physics, Trieste (Italy). Jul 1995. 7p. Order Number DE96602206. Source: OSTI; NTIS (US Sales Only); INIS.

A new model to obtain the equation of state for a dense hadron gas is given which incorporates the effect of finite-size of hadrons in a thermodynamically consistent way. Unlike earlier models, the model presents a simple and easily calculable method for incorporating the effect of excluded volume. The consequences of the model are explored and its predictions are compared with those of other models. (author). 12 refs, 1 fig.

30972 (IFVE-OTF–94-86) **On soft singular infrared behaviour of the gluon propagator.** Alekseev, A.I. Gosudarstvennyj Komitet po Ispol'zovaniyu Atomnoj Ehnergii SSSR, Serpukhov (Russian Federation). Inst. Fiziki Vysokikh Ehnergij. 1994. 16p. (In Russian). Order Number DE96602207. Source: OSTI; NTIS (US Sales Only); INIS.

Submitted to Phys. Lett.

The Schwinger-Dyson equation for the gluon propagator in the axial gauge is considered with taking into account the gauge identities for the gluon Green's functions. A study is made of the possibility of soft singular power type infrared behaviour of the gluon propagator, $D(q) \approx (q^2)^{-c}$, $q^2 \to 0$ where c is small positive number. Under certain assumptions, the characteristic equation for the exponent is obtained. It is shown that this equation has no solutions in the interval $0<c<1$. 13 refs.; 1 fig.

30973 (INIS-BR–3540, pp. 40-44) **On gravitational waves, vortices and sigma-models.** Letelier, P.S. (Universidade Estadual de Campinas, SP (Brazil). Inst. de Matematica, Estatistica e Ciencia da Computacao). Sociedade Brasileira de Fisica, Sao Paulo, SP (Brazil). 1993. 251p. (CONF-9109557–: 12. national meeting on particle physics and fields, Caxambu (Brazil), 18-22 Sep 1991). In *Proceedings of the 12. National Meeting on Particle Physics and Fields.* Order Number DE96602594. Source: OSTI; NTIS; INIS.

We find that the existence of either vortices or cosmic strings solutions is not affected by the presence of gravitational plane fronted waves and that curvature singularities appear due to the interaction between the wave and either the string of the vortex. (author). 10 refs.

30974 (INIS-BR–3540, pp. 57-65) **New baryonic force for the universe.** Souza, M.E. de (Sergipe Univ., Aracaju, SE (Brazil). Inst. de Fisica). Sociedade Brasileira de Fisica, Sao Paulo, SP (Brazil). 1993. 251p. (CONF-9109557–: 12. national meeting on particle physics and fields, Caxambu (Brazil), 18-22 Sep 1991). In *Proceedings of the 12. National Meeting on Particle Physics and Fields.* Order Number DE96602594. Source: OSTI; NTIS; INIS.

It is attempt to achieve a general classification of matter, including all kinds of matter, looking for the links between the elementary particles and the large bodies of the universe. This classification, although empirical is consistent. (M.C.K.). 11 refs, 4 figs, 2 tabs.

30975 (INIS-BR–3540, pp. 86-90) **SU(3) x U(1) model for electroweak interactions and neutrinoless double beta decay.** Pisano, F. (Instituto de Fisica Teorica (IFT), Sao Paulo, SP (Brazil)); Pleitez, V. Sociedade Brasileira de Fisica, Sao Paulo, SP (Brazil). 1993. 251p. (CONF-9109557–: 12. national meeting on particle physics and fields, Caxambu (Brazil), 18-22 Sep 1991). In *Proceedings of the 12. National Meeting on Particle Physics and Fields.* Order Number DE96602594. Source: OSTI; NTIS; INIS.

We consider a gauge model based on a SU(3) U(1) symmetry in which the lepton number is violated explicitly by charged scalar and gauge bosons, including a vector field with double electric charge. This model also produces (β β) ω with massless neutrinos. (author). 4 refs, 1 fig.

30976 (INIS-BR–3540, pp. 103) **Solitons of Skyrme model with the term of pion mass.** Mignaco, J.A. (Centro Brasileiro de Pesquisas Fisicas (CBPF), Rio de Janeiro, RJ (Brazil)); Wulck, S. Sociedade Brasileira de Fisica, Sao Paulo, SP (Brazil). 1993. 251p. (In Portuguese). (CONF-9109557–: 12. national meeting on particle physics and fields, Caxambu (Brazil), 18-22 Sep 1991). In *Proceedings of the 12. National Meeting on Particle Physics and Fields.* Order Number DE96602594. Source: OSTI; NTIS; INIS.

Short communication. SOLITONS/skyrme potential; ANALYTICAL SOLUTION; BARYON NUMBER; MASS; PIONS; SOLITONS; TOPOLOGY

30977 (INIS-BR–3540, pp. 104-108) **On the physical contents of the SU(2) Skyrme model.** Mignaco, J.A. (Centro Brasileiro de Pesquisas Fisicas (CBPF), Rio de Janeiro, RJ (Brazil)); Wulck, S. Sociedade Brasileira de Fisica, Sao Paulo, SP (Brazil). 1993. 251p. (In Portuguese). (CONF-9109557–: 12. national meeting on particle physics and fields, Caxambu (Brazil), 18-22 Sep 1991). In *Proceedings of the 12. National Meeting on Particle Physics and Fields.* Order Number DE96602594. Source: OSTI; NTIS; INIS.

This paper is a resume of another one where the solutions for the Skyrme model in the SU(2) hedgehog representation are analysed as a function of the model parameters. (L.C.J.A.). 3 refs, 2 tabs, 3 figs.

30978 (INIS-BR–3540, pp. 109-117) **Hadronic mass in the model with confinement and chiral symmetry.** Krein, G. (Instituto de Fisica Teorica (IFT), Sao Paulo, SP (Brazil)). Sociedade Brasileira de Fisica, Sao Paulo, SP (Brazil). 1993. 251p. (In Portuguese). (CONF-9109557–: 12. national meeting on particle physics and fields, Caxambu (Brazil), 18-22 Sep 1991). In *Proceedings of the 12. National Meeting on Particle Physics and Fields.* Order Number DE96602594. Source: OSTI; NTIS; INIS.

Results of heavy meson, delta baryon and nucleon mass calculation using quark model with confinement and chiral symmetry are presented. The mass of mesons are obtained solving Salpeter equation and nucleon and delta mass are obtained using variational method for Salpeter equation. (M.C.K.). 5 refs, 1 fig, 2 tabs.

30979 (INIS-BR–3540, pp. 118-121) **Mini-jets seen in cosmic ray interaction with carbon target chamber.** Navia, C.E. (Universidade Federal Fluminense, Niteroi, RJ (Brazil). Inst. de Fisica); Pinto, F.A.; Portella, H.; Pinto, H.V.; Maldonado, R.H. Sociedade Brasileira de Fisica, Sao Paulo, SP (Brazil). 1993. 251p. (CONF-9109557–: 12. national meeting on particle physics and fields, Caxambu (Brazil), 18-22 Sep 1991). In *Proceedings of the 12. National Meeting on Particle Physics and Fields.* Order Number DE96602594. Source: OSTI; NTIS; INIS.

In this work we use two different procedures by mini jets identification in cosmic ray particles interaction with carbon target chamber (C-jets) observed by Brazil-Japan Collaboration. This events concerns the overlapping energy region with CERN and FNAL collider experiments ($\sqrt{s} \approx 500$ GeV). Our results are discussed and interpreted in terms of fire-ball model and we find which those studies are common in many aspects with modern version of multi-particles production models such as quark-string inspired by QCD. (author). 4 refs, 6 figs.

30980 (INIS-BR–3540, pp. 126-129) **Baryon mass spectrum in quark diquark model.** Castro, A.S. de (UNESP, Guaratingueta, SP (Brazil). Dept. de Fisica e Quimica); Carvalho, H.F. de; Antunes, A.C.B. Sociedade Brasileira de Fisica, Sao Paulo, SP (Brazil). 1993. 251p. (In Portuguese). (CONF-9109557–: 12. national meeting on particle physics and fields, Caxambu (Brazil), 18-22 Sep 1991). In *Proceedings of the 12. National Meeting on Particle Physics and Fields.* Order Number DE96602594. Source: OSTI; NTIS; INIS.

The mass of spin 3/2 baryon fundamental states by reducing three quark problem in equivalent problem involving one and diquark are calculated. The parameters of non relativistic potential was established in mesonic sector, and differs of quark-antiquark potential by a factor associated to quadratic Casimir operator of SU(3) group. The mass spectrum obtained is compared with the

one obtained by Zickendraht and experimental method. (M.C.K.). 10 refs, 2 tabs.

30981 (INIS-BR–3540, pp. 144-147) **Supersymmetry partial algebra and the potential $V(x) = x^2 + \lambda [x^2/1 + g x^2]$.** Drigo Filho, E. (UNESP, Sao Jose do Rio Preto, SP (Brazil). Inst. de Biociencias, Letras e Ciencias Exatas); Ricotta, R.M. Sociedade Brasileira de Fisica, Sao Paulo, SP (Brazil). 1993. 251p. (In Portuguese). (CONF-9109557–: 12. national meeting on particle physics and fields, Caxambu (Brazil), 18-22 Sep 1991). In *Proceedings of the 12. National Meeting on Particle Physics and Fields*. Order Number DE96602594. Source: OSTI; NTIS; INIS.

The relation between supersymmetric quantum mechanics and partial algebra of spectral problem for solving the non polynomial potential $V(x) = x^2 + \lambda [x^2/1 + g x^2]$ is investigated. (M.C.K.). 10 refs.

30982 (INIS-BR–3540, pp. 148-151) **Solution of Schroedinger equation for two-dimensional potential using supersymmetry.** Drigo Filho, E. (UNESP, Sao Jose do Rio Preto, SP (Brazil). Inst. de Biociencias, Letras e Ciencias Exatas). Sociedade Brasileira de Fisica, Sao Paulo, SP (Brazil). 1993. 251p. (In Portuguese). (CONF-9109557–: 12. national meeting on particle physics and fields, Caxambu (Brazil), 18-22 Sep 1991). In *Proceedings of the 12. National Meeting on Particle Physics and Fields*. Order Number DE96602594. Source: OSTI; NTIS; INIS.

A method for obtaining solution of Schroedinger equation for same two dimensional potentials by unusual treatment of supersymmetric algebra in quantum mechanics is presented. The Hartmann potentials is used to illustrate the method. (M.C.K.). 5 refs.

30983 (INIS-BR–3540, pp. 172-175) **Radiative corrections in (2 + 1) dimensional QED.** Pimentel, B.M. (Instituto de Fisica Teorica (IFT), Sao Paulo, SP (Brazil)); Suzuki, A.T.; Tomazelli, J.L. Sociedade Brasileira de Fisica, Sao Paulo, SP (Brazil). 1993. 251p. (CONF-9109557–: 12. national meeting on particle physics and fields, Caxambu (Brazil), 18-22 Sep 1991). In *Proceedings of the 12. National Meeting on Particle Physics and Fields*. Order Number DE96602594. Source: OSTI; NTIS; INIS.

It was calculated the vacuum polarization tensor for (2+1)-dimensional quantum electrodynamics (QED) using the analytic regularization technique by means of a gauge invariant construct. We have thus demonstrated that the gauge boson acquires physical mass at the one-loop level in the Abelian case. A generalization for the non-Abelian case showed up straightforward from this result. (author). 11 refs.

30984 (INIS-BR–3540, pp. 176-183) **Fermions and O(3)-nonlinear sigma model in a three-dimensional space-time.** Nascimento, J.R.S. do (Paraiba Univ., Joao Pessoa, PB (Brazil). Dept. de Fisica); Mello, E.R.B. de. Sociedade Brasileira de Fisica, Sao Paulo, SP (Brazil). 1993. 251p. (CONF-9109557–: 12. national meeting on particle physics and fields, Caxambu (Brazil), 18-22 Sep 1991). In *Proceedings of the 12. National Meeting on Particle Physics and Fields*. Order Number DE96602594. Source: OSTI; NTIS; INIS.

In this paper we study the O(3)- nonlinear σ model soliton coupled with a isospin-1/2 fermion doublet by the Yukawa-type interaction. Describing the bosonic Q = 1 sector by collective coordinate, we show that a purely fermionic action can be obtained for this system. We also calculate the induced Hopf term for the bosonic sector by integrating out the fermionic degrees of freedom, and also the induced fermionic current. (author). 5 refs.

30985 (INIS-BR–3540, pp. 184-187) **The Dirac oscillator spectrum via generalized Wigner-Heisenberg oscillator algebra.** Jayaraman, J. (Paraiba Univ., Joao Pessoa, PB (Brazil). Dept. de Fisica); Rodrigues, R.L.; Vaidya, A.N. Sociedade Brasileira de Fisica, Sao Paulo, SP (Brazil). 1993. 251p. (In Portuguese). (CONF-9109557–: 12. national meeting on particle physics and fields, Caxambu (Brazil), 18-22 Sep 1991). In *Proceedings of the 12. National Meeting on Particle Physics and Fields*. Order Number DE96602594. Source: OSTI; NTIS; INIS.

The Dirac oscillator is included into the structure of Wigner-Heisenberg algebra in super realized form. Such link allows to convert Dirac oscillator spectra problem of simple Hermitian matrix in the space of member for Wigner particle, for determining complete energy spectrum. (M.C.K.). 4 refs.

30986 (INIS-BR–3540, pp. 188-191) **Coherent states via Wigner-Heisenberg algebra.** Rodrigues, R.L. (Paraiba Univ., Cajazeiras, PB (Brazil). Dept. de Ciencias Exatas e da Natureza); Vaidya, A.N.; Jayaraman, J. Sociedade Brasileira de Fisica, Sao Paulo, SP (Brazil). 1993. 251p. (In Portuguese). (CONF-9109557–: 12. national meeting on particle physics and fields, Caxambu (Brazil), 18-22 Sep 1991). In *Proceedings of the 12. National Meeting on Particle Physics and Fields*. Order Number DE96602594. Source: OSTI; NTIS; INIS.

A formalism to construct canonical coherent states of general oscillators type centrifuge barrier oscillator, is developed. It is shown that they are non orthogonals, super complete and normalizable. Extensions for generalized coherent states are discussed. (M.C.K.). 10 refs.

30987 (INIS-BR–3540, pp. 196-200) **The Feynman-Dyson proof of Maxwell equations and magnetic monopoles.** Maia Junior, A. (Universidade Estadual de Campinas, SP (Brazil). Inst. de Matematica, Estatistica e Ciencia da Computacao); Rodrigues Junior, W.A. Sociedade Brasileira de Fisica, Sao Paulo, SP (Brazil). 1993. 251p. (CONF-9109557–: 12. national meeting on particle physics and fields, Caxambu (Brazil), 18-22 Sep 1991). In *Proceedings of the 12. National Meeting on Particle Physics and Fields*. Order Number DE96602594. Source: OSTI; NTIS; INIS.

Using a violation of the Jacobi Identity we are able to generalize the Feynman's proof of the Maxwell equations including magnetic monopoles. (author). 13 refs.

30988 (INIS-BR–3540, pp. 201-208) **The vacuum energy of QED with four-fermion interaction.** Montero, J.C. (Instituto de Fisica Teorica (IFT), Sao Paulo, SP (Brazil)); Natale, A.A.; Pleitez, V.; Sobrinho, J.A.S. Sociedade Brasileira de Fisica, Sao Paulo, SP (Brazil). 1993. 251p. (CONF-9109557–: 12. national meeting on particle physics and fields, Caxambu (Brazil), 18-22 Sep 1991). In *Proceedings of the 12. National Meeting on Particle Physics and Fields*. Order Number DE96602594. Source: OSTI; NTIS; INIS.

We consider quantum electrodynamics in the quenched approximation including a four-fermion interaction with coupling constant g. The effective constants α and g and an ultraviolet cutoff Λ, showing a minimum of energy in the (α,g) plane for $\alpha = \alpha_c = \pi/3$ and $g=\infty$. When we go to the continuum limit ($\Lambda \rightarrow \infty$), keeping finite the dynamical mass, the minimum of energy moves to (α 0,g = 1), which correspond to a point where the theory is trivial. (author). 16 refs, 3 figs.

30989 (INIS-BR–3540, pp. 218-221) **Supercoherent states of SUSI 3 D radial oscillator.** Rodrigues, R.L. (Paraiba Univ., Cajazeiras, PB (Brazil). Dept. de Ciencias Exatas e da Natureza); Vaidya, A.N.; Jayaraman, J. Sociedade Brasileira de Fisica, Sao Paulo, SP (Brazil). 1993. 251p. (In Portuguese). (CONF-9109557–: 12. national meeting on particle physics and fields, Caxambu (Brazil), 18-22 Sep 1991). In *Proceedings of the 12. National Meeting on Particle Physics and Fields*. Order Number DE96602594. Source: OSTI; NTIS; INIS.

Three types of canonical super coherent states of SUSI 3 D radial oscillator are obtained. They are bosonic, fermionic and supersymmetric. (M.C.K.). 6 refs.

30990 (LBL–37425) **Pauli-Villars regulatization of supergravity and field theory anomalies.** Gaillard, M.K. Lawrence Berkeley Lab., CA (United States). Jun 1995. 8p. Sponsored by USDOE, Washington, DC (United States);National Science Foundation, Washington, DC (United States). DOE Contract AC03-76SF00098. NSF Grant PHY-90-21139. (CONF-9505289–1: Super symmetry conference, Palaiseau (France), 15-19 May 1995; UCB-PTH–95/19). Order Number DE96000140. Source: OSTI; NTIS; INIS; GPO Dep.

A procedure for Pauli-Villars regularization of locally and globally supersymmetric theories is described. Implications for specific theories, especially those obtained from superstrings, are discussed with emphasis on the role of field theory anomalies.

30991 (SLAC-PUB–95-6937) **Precision tests of quantum chromodynamics and the standard model.** Brodsky, S.J.; Lu,

H.J. Stanford Univ., CA (United States); Arizona Univ., Tucson, AZ (United States). Dept. of Physics. Jun 1995. 9p. Sponsored by USDOE, Washington, DC (United States). DOE Contract AC03-76SF00515 ; FG03-93ER40792. (CONF-9503183–2: Joint meeting of the international symposium on particles, strings and cosmology, and the 19. Johns Hopkins workshop in current problems in particle theory, Baltimore, MD (United States), 22-25 Mar 1995). Order Number DE95017727. Source: OSTI; NTIS; INIS; GPO Dep.

The authors discuss three topics relevant to testing the Standard Model to high precision: commensurate scale relations, which relate observables to each other in perturbation theory without renormalization scale or scheme ambiguity, the relationship of compositeness to anomalous moments, and new methods for measuring the anomalous magnetic and quadrupole moments of the W and Z.

30992 (SLAC-PUB–95-6960) **New phenomena beyond both the standard model and MSSM.** Hewett, J.L. Stanford Univ., CA (United States). Jul 1995. 6p. Sponsored by USDOE, Washington, DC (United States). DOE Contract AC03-76SF00515. (CONF-9505137–22: 10. topical workshop on proton-antiproton collider physics, Batavia, IL (United States), 9-13 May 1995). Order Number DE95017729. Source: OSTI; NTIS; INIS; GPO Dep.

The Standard Model (SM) is in complete agreement with present experimental data. Nevertheless, it is believed to leave many questions unanswered, and this belief has resulted in numerous attempts to find a more fundamental underlying theory. One key ingredient in the extrapolation of the SM to higher energies is to identify the complete particle spectrum at the electroweak scale. Two popular examples of theories which populate the TeV scale with a plethora of new particles are supersymmetry and technicolor. This has resulted in extensive searches for super- and techni-particles, which have been reported elsewhere at this meeting. In this talk, the author identifies other possible manifestations of new physics, and discusses their implications on hadron collider physics.

30993 (UCRL-ID–121571, pp. Paper 15, 15 Pages) **A photo spectrometer PHOS for the ALICE experiment at the LHC.** Manko, V. Lawrence Berkeley Lab., CA (United States). 15 Jul 1995. (CONF-950198–: Physics with the collider detectors at Relativistic Heavy Ion Collider (RHIC) and the LHC, Livermore, CA (United States), 8 Jan 1995). In *Physics with the collider detectors at RHIC and the LHC.* 212p. Order Number DE95015976. Source: OSTI; NTIS; INIS; GPO Dep.

Electromagnetic probes are a unique tool to study the early and hot phases of nuclear collisions, because the produced photons (as well as lepton pairs) escape from the finite system without reenteraction. Prompt photons is one among very few signals which can provide direct information on these, partonic phases. The thermal radiation from the quark-gluon plasma (QGP) and mixed phase could be observable in the medium p_t range (around 1-3 GeV/c). Direct photons from the pre-equilibrium phase (3-6 GeV/c) contain information on the parton dynamics at very early stages, about equilibrium times, and about the transition from perturbative to non-perturbative phenomena. At still higher momenta, direct photons originate mainly from initial hard processes and can be used to extract structure functions in nuclei.

6623 Specific Interactions, Decays and Processes

Refer also to citation(s) 30963, 30964, 30965, 30966, 30969, 31022, 31026, 31027, 31045, 31052, 31064

30994 (DOE/ER/40150–299) **Workshop on CEBAF at higher energies.** Isgur, N.; Stoler, P. (eds.). Southeastern Universities Research Association, Inc., Newport News, VA (United States). Apr 1994. 545p. Sponsored by USDOE, Washington, DC (United States). DOE Contract AC05-84ER40150. (CONF-9404197–: Workshop on CEBAF at higher energies, Newport News, VA (United States), 14-16 Apr 1994; CEBAF-R–95-001). Order Number DE96001410. Source: OSTI; NTIS; INIS; GPO Dep.

Since the current parameters of CEBAF were defined almost a decade ago, there has been a remarkably fruitful evolution of our picture of the behavior of strongly interacting matter that apparently could be addressed by CEBAF at higher energies. Favorable technical developments coupled with foresight in initial laboratory planning have now made it feasible to consider approximately doubling CEBAF's current design energy of 4 GeV to approach 10 GeV at rather modest cost. The purpose of the workshop, sponsored by the CEBAF User Group, was to begin to develop the next phase of CEBAF's program by giving the entire community the opportunity to participate in defining the future of our field, and in particular the physics accessible with an upgraded CEBAF energy. It is intended that this report mark the first step toward an ultimate goal of defining a physics program that will form the basis for an upgrade of CEBAF. The report begins with a brief overview of the workshop's conclusions. Its body consists of sections corresponding to the workshop's Working Groups on Hadron Spectroscopy and Production, High Q^2 Form Factors and Exclusive Reactions, Inclusive and Semi-Inclusive Processes, and Hadrons in the Nuclear Medium. Each section begins with the working group summaries and is followed by associated plenary talks summarizing the outstanding physics issues addressable by an upgrade, which are in turn followed by individual contributions presenting specific physics programs. An appendix describes capabilities of CEBAF's current experimental equipment at higher energies; another appendix lists workshop participants. Selected papers have been processed separately for inclusion in the Energy Science and Technology Database.

30995 (DOE/ER/40160–12) **High energy hadron-hadron collisions. Final report.** Chou, T.T. Georgia Univ., Athens, GA (United States). Dept. of Physics and Astronomy. Aug 1995. 16p. Sponsored by USDOE, Washington, DC (United States). DOE Contract FG09-84ER40160. Order Number DE95017764. Source: OSTI; NTIS; INIS; GPO Dep.

This project of studying high energy collision phenomena with the geometrical model has been undertaken and developed by this investigator and collaborators since 1967. Instead of basing conjectures on mathematical extrapolations from some ad hoc theories, this approach was to scrutinize first the general features of the phenomena before going into specific details. This particular method has proved successful in correlating experimental data, suggesting experiments, predicting new phenomena and guiding future experimental studies. In the following, important results of the geometrical model obtained with the support of the DOE grant are summarized in three parts: the elastic hadron-hadron scattering, the inelastic hadron-hadron collision, and the hadronic production in e^+e^- annihilation. The fourth part of this report outlines the results of other topics of investigation. To avoid repetition, only the main physical ideas and essential experimental evidences are presented, leaving out detailed discussions which can be found in the literature and previous reports.

30996 (FNAL/C–95/152-E) **Search for new particles decaying to dijets, $b\bar{b}$, and $t\bar{t}$ at CDF.** Harris, R.M. CDF Collaboration. Fermi National Accelerator Lab., Batavia, IL (United States). 15 Jun 1995. 10p. Sponsored by USDOE, Washington, DC (United States). DOE Contract AC02-76CH03000. (CONF-9505137–3: 10. topical workshop on proton-antiproton collider physics, Batavia, IL (United States), 9-13 May 1995). Order Number DE95013873. Source: OSTI; NTIS; INIS; GPO Dep.

We present three searches for new particles at CDF. First, using 70 pb^{-1} of data we search the dijet mass spectrum for resonances. There is an upward fluctuation near 550 GeV/c^2 (2.6σ) with an angular distribution that is adequately described by either QCD alone or QCD plus 5% signal. There is insufficient evidence to claim a signal, but we set the most stringent mass limits on the hadronic decays of axigluons, excited quarks, technirhos, W′, Z′, and E6 diquarks. Second, using 19 pb^{-1} of data we search the b-tagged dijet mass spectrum for $b\bar{b}$ resonances. Again, an upward fluctuation near 600 GeV/c^2 (2σ) is not significant enough to claim a signal, so we set the first mass limits on topcolor bosons. Finally, using 67 pb^{-1} of data we search the top quark sample for $t\bar{t}$ resonances like a topcolor Z′. Other than an insignificant shoulder of 6 events on a background of 2.4 in the mass region 475–550 GeV/c^2, there is no evidence for new particle production. Mass limits, currently in progress, should be sensitive to a topcolor Z′ near 600 GeV/c^2. In all three searches there is insufficient evidence to claim

new particle production, yet there is an exciting possibility that the upward fluctuations are the first signs of new physics beyond the standard model.

30997 (FNAL–C-95/165-E) **Search for anomalous couplings in WW and WZ measurements at the Tevatron (D0 and CDF results).** Diehl, H.T. D0 Collaboration; CDF Collaboration. Fermi National Accelerator Lab., Batavia, IL (United States). Jun 1995. 14p. Sponsored by USDOE, Washington, DC (United States). DOE Contract AC02-76CH03000. (CONF-9508155–12: 17. international symposium on lepton-photon interactions, Beijing (China), 10-15 Aug 1995). Order Number DE95016194. Source: OSTI; NTIS; INIS; GPO Dep.

The search for WW and WZ production in $p\bar{p}$ collisions at $\sqrt{s}$ = 1.8 TeV using the CDF and D0 detectors is presented. Three analyses, one concentrating on the leptons + jets decay channels and two concentrating on the dilepton decay channels are described in detail. Limits on anomalous WWγ and WWZ trilinear gauge boson couplings are presented. Prospects for further study of diboson production and anomalous couplings with the Upgraded Tevatron are also presented.

30998 (FNAL/C–95/174-E) **Photon production at CDF and D0.** Lamoureux, J.I. Brookhaven National Lab., Upton, NY (United States). Jul 1995. 9p. Sponsored by USDOE, Washington, DC (United States). DOE Contract AC02-76CH03000. (CONF-9505137–25: 10. topical workshop on proton-antiproton collider physics, Batavia, IL (United States), 9-13 May 1995). Order Number DE96000261. Source: OSTI; NTIS; INIS; GPO Dep.

Prompt photon production has been studied in $\bar{p}p$ collisions at $\sqrt{s}$ = 1.8 TeV using the CDF and D0 detectors at Fermilab. The measured inclusive isolated photon spectral at CDF and Do are used to test NLO QCD predictions. The CDF result shows that additional soft radiation (K_T) in excess of NLO QCD is required to explain the data. No new resonance is observed in the photon + jet mass spectrum from D0 which is consistent with NLO QCD predictions. The pseudorapidity distribution of the leading jet in photon events at CDF is compared to different parton distribution sets. The angular distribution is found to be better explained by a larger Bremsstrahlung contribution.

30999 (FNAL/C–95/201-E) **Limits on rare B decays $B \to \mu^+\mu^-K^\pm$ and $B \to \mu^+\mu^-K^{*0}$.** Anway-Wiese, C. CDF Collaboration. Fermi National Accelerator Lab., Batavia, IL (United States). Jul 1995. 12p. Sponsored by USDOE, Washington, DC (United States);National Science Foundation, Washington, DC (United States). DOE Contract AC02-76CH03000. (CONF-9508155–1: 17. international symposium on lepton-photon interactions, Beijing (China), 10-15 Aug 1995). Order Number DE95016699. Source: OSTI; NTIS; INIS; GPO Dep.

The authors report on a search for flavor-changing neutral current decays of B mesons $B \to \mu^+\mu^-K^\pm$ and $B \to \mu^+\mu^-K^{*0}$ using data obtained in the Collider Detector at Fermilab (CDF) 1992–1993 data taking run. To reduce the amount of background in the data the authors use precise tracking information from the CDF silicon vertex detector to pinpoint the location of the decay vertex of the B candidate, and accept only events which have a large decay time. They compare this data to a B meson signal obtained in a similar fashion, but where the muon pairs originate from ψ decays, and calculate the relative branching ratios. In absence of any indication of flavor-changing neutral current decays they set an upper limits of $BR(B \to \mu^+\mu^-K^\pm) < 1.1 \times 10^{-5}$, and $BR(B \to \mu^+\mu^-K^{*0}) < 2.1 \times 10^{-5}$ at 90% confidence level, which are consistent with Standard Model expectations but leave little room for non-standard physics.

31000 (FNAL/C–95/205-E) **J/ψ production in $p\bar{p}$ collisions at $\sqrt{s}$ = 1.8 TeV.** Abachi, S. D0 Collaboration. Fermi National Accelerator Lab., Batavia, IL (United States). Jul 1995. 11p. Sponsored by USDOE, Washington, DC (United States);National Science Foundation, Washington, DC (United States);CEA, 75 - Paris (France);Ministry of Science and Technology Policy (Russian Federation);Russian Atomic Energy Commission, Moscow (Russian Federa DOE Contract AC02-76CH03000. (CONF-950705–18: HEP 95: international Europhysics conference on high-energy physics, Brussels (Belgium), 21-27 Jul 1995). Order Number DE95017462. Source: OSTI; NTIS; INIS; GPO Dep.

The authors have studied J/ψ production in $p\bar{p}$ collisions at $\sqrt{s}$ = 1.8 TeV with the D0 detector at Fermilab, using a $\mu^+\mu^-$ data sample corresponding to an integrated luminosity of 13 pb^{-1}. They have measured the inclusive J/ψ production cross section as a function of J/ψ transverse momentum p_T. For the kinematic range $p_T > 8$ GeV/c and $|\eta| < 0.6$ they obtain $Br(J/\psi \to \mu^+\mu^-) \cdot \sigma(p\bar{p} \to J/\psi + X) = 1.93 \pm 0.16(stat) \pm 0.43(syst)$ nb. Using the muon impact parameter they have estimated the fraction of J/ψ mesons coming from B meson decays to be $f_b = 0.35 \pm 0.09$ (stat) $\pm$ 0.10 (syst) and inferred the inclusive b production cross section. From the information on the event topology a fraction of non-isolated J/ψ events has been measured to be $f_{non-isol} = 0.64 \pm 0.09(stat) \pm 0.06(syst)$. They have also obtained the fraction of events resulting from radiative decays of χ_c states as $f_\chi = 0.30 \pm 0.07(stat) \pm 0.07(syst)$. They discuss the implications of the measurements for charmonium production processes.

31001 (FNAL/C–95/249-E) **Limits on the anomalous ZZγ and Z$\gamma\gamma$ couplings in $p\bar{p}$ collisions at $\sqrt{s}$ = 1.8 TeV.** Abachi, S. D0 Collaboration. Fermi National Accelerator Lab., Batavia, IL (United States). Jul 1995. 9p. Sponsored by USDOE, Washington, DC (United States);National Science Foundation, Washington, DC (United States);CEA, 75 - Paris (France). DOE Contract AC02-76CH03000. (CONF-9508155–14: 17. international symposium on lepton-photon interactions, Beijing (China), 10-15 Aug 1995). Order Number DE95016198. Source: OSTI; NTIS; INIS; GPO Dep.

The authors performed a direct search for the anomalous ZZγ and Z$\gamma\gamma$ couplings by studying $p\bar{p} \to \ell\ell\gamma + X$, ($\ell = e, \mu$) events at $\sqrt{s}$ = 1.8 TeV with the D0 detector at the Fermilab Tevatron Collider. A fit to the transverse energy spectrum of the photon in the signal events, based on the data set corresponding to an integrated luminosity of 14.3 pb^{-1} (13.7 pb^{-1}) for the electron (muon) channel, yields the following 95% confidence level limits on the anomalous CP-conserving ZZγ couplings: $|h_{30}^Z| < 1.8$ ($h_{40}^Z = 0$), and $|h_{40}^Z| < 0.5$ ($h_{30}^Z = 0$), for a form-factor scale Λ = 500 GeV. Limits for the Z$\gamma\gamma$ couplings and CP-violating couplings are also discussed.

31002 (FNAL/C–222-E) **Measurement of the B^+ and B^0 meson lifetimes using exclusive $B \to \psi K$ decays at CDF.** Abe, F. CDF Collaboration. Fermi National Accelerator Lab., Batavia, IL (United States). Jul 1995. 5p. Sponsored by USDOE, Washington, DC (United States). DOE Contract AC02-76CH03000. (CONF-9508155–9: 17. international symposium on lepton-photon interactions, Beijing (China), 10-15 Aug 1995). Order Number DE95016197. Source: OSTI; NTIS; INIS; GPO Dep.

The authors present recent CDF measurements of τ^+, τ^0, and τ^+/τ^0 using exclusive $B \to \psi K$ decays, where B = B^+ or B^0, ψ = J/ψ or ψ(2S), and K = K^+, $K^*(892)^0$, K_S^0, or $K^*(892)^+$. The precision of these results is less than 10% and is nearly identical to that previously reported at LEP.

31003 (FNAL/C–229-E) **Search for the decay $B^0 \to \mu^+\mu^-$.** Abe, F. CDF Collaboration. Fermi National Accelerator Lab., Batavia, IL (United States). Jul 1995. 9p. Sponsored by USDOE, Washington, DC (United States). DOE Contract AC02-76CH03000. (CONF-9508155–11: 17. international symposium on lepton-photon interactions, Beijing (China), 10-15 Aug 1995). Order Number DE95016195. Source: OSTI; NTIS; INIS; GPO Dep.

The authors present a search for the decays $B_d^0 \to \mu^+\mu^-$ and $B_s^0 \to \mu^+\mu^-$ using 17.8 pb^{-1} of data collected with the Collider Detector at Fermilab (CDF) during 1992–1993 data taking period. They find no B_d^0 candidates in a mass window of [5.205, 5.355] GeV/c^2 and 1 B_s^0 candidate in a mass window of [5.300, 5.450] GeV/c^2. Normalizing to the measured cross-section σ (B^+) = 2.39 $\pm$ 0.54 μb for $p_t(B) > 6$ GeV/c and $|y(B)| < 1$ and assuming $\sigma(B^+) = \sigma(B_d^0) = 3\sigma(B_s^0)$, they find $Br(B_d^0 \to \mu^+\mu^-) < 1.6 \times 10^{-6}$ and $Br(B_s^0 \to \mu^+\mu^-) < 8.4 \times 10^{-6}$ at 90% confidence level. These limits are significant improvements of previous measurements.

31004 (FNAL/C–233-E) **Measurement of the polarization in the decays $B^0 \to J/\psi K^{*0}$ and $B_s^0 \to J/\psi\phi$.** Abe, F. CDF Collaboration. Fermi National Accelerator Lab., Batavia, IL (United States). Jul 1995. 10p. Sponsored by USDOE, Washington, DC (United

States);National Science Foundation, Washington, DC (United States);Istituto Nazionale di Fisica Nucleare, Rome (Italy);Natural Sciences and Engineering Research Council of Canada, Ottawa, ON (Canada);Ministry of DOE Contract AC02-76CH03000. (CONF-9508155–10: 17. international symposium on lepton-photon interactions, Beijing (China), 10-15 Aug 1995). Order Number DE95016196. Source: OSTI; NTIS; INIS; GPO Dep.

The authors report on a measurement of the longitudinal polarization fraction in the decay $B^0 \rightarrow J/\psi K^{*0}$ using data collected with the Collider Detector at Fermilab. B^0 mesons are reconstructed through the decay chain $B^0 \rightarrow J/\psi\ K^{*0}$, $J/\psi \rightarrow \mu^+\mu^-$, $K^{*0} \rightarrow K^+\pi^-$. A sample of 65 ± 10 events is used to obtain the result $\Lambda_L/\Lambda = 0.65 \pm 0.10$ (stat) ± 0.04 (sys). The first measurement of Λ_L/Λ in the decay $B_s{}^0 \rightarrow J/\psi\phi$ is also presented.

31005 (IC–95/112) **Cabibbo favored hadronic decays of charmed baryons in flavor SU(3).** Verma, R.C. (International Centre for Theoretical Physics, Trieste (Italy)); Khanna, M.P. International Centre for Theoretical Physics, Trieste (Italy). Jun 1995. 20p. Order Number DE96602217. Source: OSTI; NTIS (US Sales Only); INIS.

The two body Cabibbo favored hadronic decays of charmed baryons Λ^+_c, Ξ^+_c and Ξ^0_c into an octet or decuplet baryon and a pseudoscalar meson are examined in the SU(3) symmetry scheme. The numerical estimates for decay widths and branching ratios of some of the modes are obtained and are in good agreement with experiment. (author). 16 refs, 5 tabs.

31006 (INIS-BR–3540, pp. 91-94) **Form factors of the charmed meson decays $D^+ \rightarrow$ K-bar ^{0*} e^+ v.** Ball, P. (Heidelberg Univ. (Germany). Inst. fuer Theoretische Physik); Dosch, H.G.; Ferreira, E. Sociedade Brasileira de Fisica, Sao Paulo, SP (Brazil). 1993. 251p. (CONF-9109557–: 12. national meeting on particle physics and fields, Caxambu (Brazil), 18-22 Sep 1991). In *Proceedings of the 12. National Meeting on Particle Physics and Fields.* Order Number DE96602594. Source: OSTI; NTIS; INIS.

As an attempt to explain discrepancies between experimental results and theoretical calculations on the ratios between longitudinal and traversal polarizations of the $K^{-}o^{*}$ meson in the semileptonic D^+ decay, we evaluate the simplest hadronic corrections to the form factors. We show that the influence of these corrections is too small to account for the existing discrepancies. (author). 11 refs, 1 fig, 1 tab.

31007 (JINR-E–4-94-123, pp. 49) **Two pion photoproduction on the proton: $p(\gamma,\pi^+\pi^0)$ and $p(\gamma,\pi^0\pi^0)p$1.** Strober, H. (Giessen Univ. (Germany)). Joint Inst. for Nuclear Research, Dubna (Russian Federation). 1994. 126p. (CONF-9405202–: Mesons and nuclei at intermediate energies, Dubna (Russian Federation), 3-7 May 1994). In *Mesons and nuclei at intermediate energies. International conference. Book of abstracts.* Order Number DE95633649. Source: OSTI; NTIS (US Sales Only); INIS.

Short communication. 2 refs. PIONS NEUTRAL/particle production; PIONS PLUS/particle production; MEV RANGE 100-1000; NEUTRONS; PHOTON-PROTON INTERACTIONS; PROTONS

31008 (LA-UR–95-1822) **The search for proton decay.** Haines, T. (Los Alamos National Lab., NM (United States)); Kaneyuki, K.; McGrew, C.; Mohapatra, R.; Peterson, E.; Cline, D.B. Los Alamos National Lab., NM (United States). [1994]. 20p. Sponsored by USDOE, Washington, DC (United States). DOE Contract W-7405-ENG-36. (CONF-9406269–6: Snowmass 94: particle and astrophysics in the next millenium, Snowmass, CO (United States), 29 Jun - 14 jul 1994). Order Number DE95015315. Source: OSTI; NTIS; INIS; GPO Dep.

The conservation of the quantum number called baryon number, like lepton (or family) number, is an empirical fact even though there are very good reasons to expect otherwise. Experimentalists have been searching for baryon number violating decays of the proton and neutron for decades now without success. Theorists have evolved deep understanding of the relationship between the natural forces in the development of various Grand Unified Theories (GUTs) that nearly universally predict baryon number violating proton decay, or related phenomena like n-ñ oscillations. With this in mind, the Proton Decay Working Group reviewed the current experimental and theoretical status of the search for baryon number violation with an eye to the advancement in the next decade.

31009 (LA-UR–95-1858) **Strong interaction physics with pions at LAMPF: Report of the study group on future opportunities at LAMPF.** Johnson, M.B. (Los Alamos National Lab., NM (United States)); Matthews, J.L. Los Alamos National Lab., NM (United States). [1995]. 30p. Sponsored by USDOE, Washington, DC (United States). DOE Contract W-7405-ENG-36. Order Number DE95015252. Source: OSTI; NTIS; INIS; GPO Dep.

The LAMPF accelerator, with its high-intensity teams of pions and array of high-resolution spectrometers, provides opportunities for investigations of nuclear structure as well as of strong-interaction hadron dynamics. During operation of LAMPF as a national users facility, Nuclear Physics has undergone an evolution in the way it pictures nuclei: from a system of nucleons interacting through potentials to a system of mutually coupled nucleons, Δ(1232)'s, and mesons. While nuclear physics is in the midst of yet another shift of paradigm, with quarks and gluons playing a central role, the traditional picture still has great predictive power, and LAMPF has new opportunities to contribute to solving problems of current interest. At the same time, LAMPF is poised to make important contributions to the evolving area of nonperturbative QCD, where we will be learning how to connect phenomena at large momentum transfer to those at lower momentum scales. where the physically observable hadrons are the natural degrees of freedom. Within the traditional area, exploration of nuclei having extreme ratios of neutron/proton number is of growing interest in a variety of contexts, including astrophysics. Pion double charge exchange (the $(\pi^{\pm}, \pi^{\pm})$ processes) can produce proton-rich nuclei such as ^{9}C, ^{10}C, and ^{11}N as well as neutron-rich nuclei such as ^{10}He, ^{11}Li, ^{14}Be, and ^{17}B. With spectrometers available for analyzing the outgoing pion spectra, one can study interesting and controversial modes of motion (soft-dipole modes) and obtain angular distributions that explore the spatial extent of neutron halos.

31010 (LBL–37244) **W_γ and Z_γ production at Tevatron.** Aihara, H. Lawrence Berkeley Lab., CA (United States). May 1995. 19p. Sponsored by USDOE, Washington, DC (United States). DOE Contract AC03-76SF00098. (CONF-950287–5: International symposium on vector boson interactions, Los Angeles, CA (United States), 1-3 Feb 1995). Order Number DE95014791. Source: OSTI; NTIS; INIS; GPO Dep.

We present results from CDF and D0 on W_γ and Z_γ productions in $p\bar{p}$ collisions at $\sqrt{s}$ = 1.8 TeV. The goal of the analyses is to test the non-abelian self-couplings of the W, Z and photon, one of the most direct consequences of the $SU(2)_L \otimes U(l)_Y$ gauge symmetry. We present direct measurements of WW_γ couplings and limits on ZZ_γ and $Z_{\gamma\gamma}$ couplings, based on $p\bar{p} \rightarrow l\nu\gamma + X$ and $p\bar{p} \rightarrow ll\gamma + X$ events, respectively, observed during the 1992–1993 run of the Fermilab Tevatron Collider.

31011 (LBL–37507) **Measurements of the W and Z inclusive cross sections and determination of the W decay width.** Spadafora, A.L. (Lawrence Berkeley Lab., CA (United States). Physics Div.). Lawrence Berkeley Lab., CA (United States). Jul 1995. 10p. Sponsored by USDOE, Washington, DC (United States). DOE Contract AC03-76SF00098. (CONF-9505137–24: 10. topical workshop on proton-antiproton collider physics, Batavia, IL (United States), 9-13 May 1995). Order Number DE96000130. Source: OSTI; NTIS; INIS; GPO Dep.

Recent results on the production of W and Z gauge bosons in $p\bar{p}$ collisions at $\sqrt{s}$ = 1.8 TeV at the Fermilab Tevatron Collider from the D0 and CDF experiments are reviewed. Measurements of the inclusive cross sections times leptonic branching ratios in both the electron and muon decay channels are summarized and compared to QCD predictions. Using the ratio $R = \sigma_W \cdot B(W \rightarrow lv)/\sigma_Z \cdot B(Z \rightarrow ll)$ and assuming standard model couplings, an indirect determination of the W decay width is obtained. By comparing this measured value with the predicted value for the W width, a limit on the deviation from the standard model is obtained.

31012 (SLAC–452) **A precise measurement of the left-right asymmetry of Z Boson production at the SLAC linear collider.** Stanford Univ., CA (United States). Sep 1994. 173p. Sponsored by

USDOE, Washington, DC (United States). DOE Contract AC03-76SF00515. Order Number DE95014375. Source: OSTI; NTIS; INIS; GPO Dep.

We present a precise measurement of the left-right cross section asymmetry of Z boson production (A_{LR}) observed in 1993 data at the SLAC linear collider. The A_{LR} experiment provides a direct measure of the effective weak mixing angle through the initial state couplings of the electron to the Z. During the 1993 run of the SLC, the SLD detector recorded 49,392 Z events produced by the collision of longitudinally polarized electrons on unpolarized positrons at a center-of-mass energy of 91.26 GeV. A Compton polarimeter measured the luminosity-weighted electron polarization to be (63.4±1.3)%. ALR was measured to be 0.1617±0.0071(stat.)±0.0033(syst.), which determines the effective weak mixing angle to be $\sin^2\theta_W^{eff}$ = 0.2292±0.0009(stat.)±0.0004(syst.). This measurement of A_{LR} is incompatible at the level of two standard deviations with the value predicted by a fit of several other electroweak measurements to the Standard Model.

31013 (SLAC–454) **A precise measurement of the left-right cross section asymmetry in Z boson production.** Lath, A. Stanford Univ., CA (United States). Sep 1994. 178p. Sponsored by USDOE, Washington, DC (United States). DOE Contract AC03-76SF00515. Order Number DE95014376. Source: OSTI; NTIS; INIS; GPO Dep.

The thesis presents a measurement of the left-right asymmetry, A_{LR}, n the production cross section of Z Bosons produced by e^+e^- annihilations, using polarized electrons, at a center of mass energy of 91.26 Gev. The data presented was recorded by the SLD detector at the SLAC Linear Collider during the 1993 run. The mean luminosity-weighted polarization of the electron beam was ρ^{lum} = (63.0±1.1)%. Using a sample of 49,392 Z events, we measure A_{LR} to be 0.1626±0.0071(stat)±0.0030(sys.), which determined the effective weak mixing angle to be $\sin^2\theta_W^{eff}$ = 0.2292±0.0009(stat.)±0.0004(sys.). This result differs from that expected by the Standard Model of Particles and Fields by 2.5 standard deviations.

31014 (SLAC-PUB–95-6916) **Test of T and CP violation in leptonic decay of $\tau^\pm$.** Tsai, Yung Su. Stanford Linear Accelerator Center, Menlo Park, CA (United States). Jun 1995. 8p. Sponsored by USDOE, Washington, DC (United States). DOE Contract AC03-76SF00515. (CONF-9506186–1: Workshop on the Tau/Charm Factory, Argonne, IL (United States), 21-23 Jun 1995). Order Number DE95016510. Source: OSTI; NTIS; INIS; GPO Dep.

The $\tau^\pm$, highly polarized in the direction of the incident beam, can be obtained from the $e^\pm$ collider with the polarized incident e^- (and preferably also the e^+) beam. This polarization vector $\vec{\omega}_i = (\omega_1 + \omega_2)/(1 + \omega_1\omega_2)\hat{e}_z$ can be used to construct the T odd rotationally invariant product $(\vec{\omega}_i \times \vec{p}_\mu) \cdot \vec{\omega}_\mu$, where ω_1 and ω_2 are longitudinal polarization vectors of e^- and e^+ respectively; $\vec{p}_\mu$ and $\vec{\omega}_\mu$ are the momentum and polarization of the muon in the decay $\tau^- \to \mu^- + \bar{\nu}_\mu + \nu_\tau$. T is violated by the existence of such a term. CP can be tested by comparing it with a similar term in τ^+ decay. If T violation in such a decay is milliweak or stronger, one can find it using the proposed polarized τ-charm factory with luminosity of $1 \sim 3 \times 10^{33}/cm^2/sec$. One can test whether T (and CP) violation is due to the charged Higgs boson exchange by doing a similar experiment for the $\mu^\pm$ decay.

31015 (SLAC-PUB–95-6933) **The production of $\pi^\pm$, $K^\pm$, p, K^0 and Λ^0 in hadronic Z^0 decays.** Baird, K. (Rutgers-the State Univ., Piscataway, NJ (United States)). SLD Collaboration. Stanford Univ., CA (United States); Boston Univ., MA (United States). Dept. of Physics; California Inst. of Tech., Pasadena, CA (United States); California Univ., Santa Barbara, CA (United States); California Univ., Santa Cruz, CA (United States); Colorado State Univ., Fort Collins, CO (United States); Colorado Univ., Boulder, CO (United States); Illinois Univ., Urbana, IL (United States); California Univ., Berkeley, CA (United States); Massachusetts Univ., Amherst, MA (United States); Massachusetts Inst. oAug 1995. 5p. Sponsored by USDOE, Washington, DC (United States);National Science Foundation, Washington, DC (United States);Science and Engineering Research Council, Swindon (United Kingdom);Istituto Nazionale di Fisica Nucleare, Rome (Italy);Japan-US Cooperative Rese DOE Contract AC03-76SF00515 ; FG02-91ER40676 ; FG03-92ER40701 ; FG03-91ER40618 ; FG03-92ER40689 ; FG03-93ER40788 ; FG02-91ER406Grant PHY-91-13428; Grant PHY-89-21320; Grant PHY-92-04239; Gran (CONF-9503158–19: 30. Rencontres de Moriond on QCD and high energy interactions, Les Arcs (France), 19-26 Mar 1995). Order Number DE95017368. Source: OSTI; NTIS; INIS; GPO Dep.

The authors have measured production fractions and spectra for $\pi^\pm$, $K^\pm$ and p, and production spectra for K^0 and Λ^0 in both hadronic Z^0 decays and a $Z^0 \to$ light quark (uds) subset at SLD. The SLD Cherenkov Ring Imaging Detector was used to identify charged hadrons. The CCD vertex detector was used to select the enriched uds sample. For the global sample, the results are consistent with previous experiments. The authors observe a clear flavor dependence in production spectra, but only a small effect in hadron fractions and $\xi = \ln(1/x_p)$ peak positions.

31016 (SLAC-PUB–95-7004) **The lifetime probability tag measurement of R_b using the SLD.** SLD Collaboration. Stanford Linear Accelerator Center, Menlo Park, CA (United States); Boston Univ., MA (United States). Dept. of Physics; California Inst. of Tech., Pasadena, CA (United States); California Univ., Santa Barbara, CA (United States); California Univ., Santa Cruz, CA (United States); Colorado State Univ., Fort Collins, CO (United States); Colorado Univ., Boulder, CO (United States); Illinois Univ., Urbana, IL (United States); California Univ., Berkeley, CA (United States); Massachusetts Univ., Amherst, MA (UniteAug 1995. 11p. Sponsored by USDOE, Washington, DC (United States);National Science Foundation, Washington, DC (United States);Science and Engineering Research Council, Swindon (United Kingdom);Istituto Nazionale di Fisica Nucleare, Rome (Italy);Japan-US Cooperative Rese DOE Contract FG02-91ER40676 ; FG03-92ER40701 ; FG03-91ER40618 ; FG03-92ER40689 ; FG03-93ER40788 ; FG02-91ER40672 ; FG02-91ER406Grant PHY-91-13428; Grant PHY-89-21320; Grant PHY-92-04239; Gran (CONF-950705–17: HEP 95: international Europhysics conference on high-energy physics, Brussels (Belgium), 21-27 Jul 1995). Order Number DE96001023. Source: OSTI; NTIS; INIS; GPO Dep.

The authors present a new measurement of $R_b = \Lambda_{Z^0 \to b\bar{b}}/\Lambda_{Z^0 \to hadrons}$ using a lifetime double tag on 150k hadronic Z^0 events collected from the SLD 1993 and 1994 runs. The method utilizes the high precision 3-D position measurements provided by the CCD vertex detector and the small stable SLC beams to obtain a b hemisphere tagging efficiency of 31% for a purity of 94%. The b-Hemisphere tagging efficiency is measured from the data reducing dependence on the B-decay model and detector simulation. They obtain a result of $R_b = 0.2171 \pm 0.0040_{statistical} \pm 0.0037_{systematic} \pm 0.0023_{R_c}$.

31017 (SLAC-R–95-473) **Measurements of $\Gamma(Z^0 \to b\bar{b})/\Gamma(Z^0 \to$ hadrons) using the SLD.** Neal, H.A. Jr. II. Stanford Univ., CA (United States). Jul 1995. 175p. Sponsored by USDOE, Washington, DC (United States). DOE Contract AC03-76SF00515. Order Number DE96000817. Source: OSTI; NTIS; INIS; GPO Dep.

The quantity $R_b = \Gamma(Z^0 \to b\bar{b})/\Gamma(Z^0 \to$ hadrons) is a sensitive measure of corrections to the Zbb vertex. The precision necessary to observe the top quark mass dependent corrections is close to being achieved. LEP is already observing a 1.8σ deviation from the Standard Model prediction. Knowledge of the top quark mass combined with the observation of deviations from the Standard Model prediction would indicate new physics. Models which include charged Higgs or light SUSY particles yield predictions for R_b appreciably different from the Standard Model. In this thesis two independent methods are used to measure R_b. One uses a general event tag which determines R_b from the rate at which events are tagged as $Z^0 \to b\bar{b}$ in data and the estimated rates at which various flavors of events are tagged from the Monte Carlo. The second method reduces the reliance on the Monte Carlo by separately tagging each hemisphere as containing a b-decay. The rates of single hemisphere tagged events and both hemisphere tagged events are used to determine the tagging efficiency for b-quarks directly from the data thus eliminating the main sources of systematic error present in the event tag. Both measurements take

advantage of the unique environment provided by the SLAC Linear Collider (SLC) and the SLAC Large Detector (SLD). From the event tag a result of $R_b = 0.230 \pm 0.004_{statistical} \pm 0.013_{systematic}$ is obtained. The higher precision hemisphere tag result obtained is $R_b = 0.218 \pm 0.004_{statistical} \pm 0.004_{systematic} \pm 0.003_{Rc}$.

31018 (UCRL-ID–121571, pp. Paper 13, 11 Pages) **Electron measurement in PHENIX.** Akiba, Y. (Univ. of Tokyo, Tanashi (Japan)). Lawrence Berkeley Lab., CA (United States). 15 Jul 1995. (CONF-950198–: Physics with the collider detectors at Relavitistic Heavy Ion Collider (RHIC) and the LHC, Livermore, CA (United States), 8 Jan 1995). In *Physics with the collider detectors at RHIC and the LHC.* 212p. Order Number DE95015976. Source: OSTI; NTIS; INIS; GPO Dep.

Electron Measurement in PHENIX detector at RHIC is discussed. The yield and S/N ratio at vector meson peaks (ϕ, ω, ρ^0, and J/ψ) are evaluated. The electrons from open charm decay, and its consequence to the di-electron measurements is discussed.

31019 (UM-P–94/81) **Transverse electric form factors for electron scattering and violation of current conservation in nuclear models.** Karataglidis, S.; Halse, P.; Amos, K. Melbourne Univ., Parkville, VIC (Australia). School of Physics. 28 Jul 1994. 29p. Order Number DE96602830. Source: OSTI; NTIS; INIS.

Comparison is made between calculations of transverse electric form factors using the standard expression for the electric multipole operator with those obtained by invoking current conservation first in the long wavelength limit and second for arbitrary momentum transfer. Results are presented for select E2 transitions in ^{12}C, ^{20}Ne, ^{24}Mg, and ^{28}Si. It is found that the form factors differ significantly when the conventional shell model wave functions are used, confirming that these do violate current conservation. However, the variation between results is much smaller when multi-shell models of nuclear structure are used. All three forms of the operator yield comparable good agreement with existing data indicating that wave functions obtained from these models are largely current conserving. 19 refs., 5 tabs., 7 figs.

31020 (UM-P–94/115) **A meson-exchange isobar model for the $\pi^+ d \rightleftarrows pp$ reaction.** Canton, L. (Istituto Nazionale di Fisica Nucleare, Padua (Italy)); Cattapan, G.; Dortmans, P.J.; Pisent, G.; Svenne, J.P. Melbourne Univ., Parkville, VIC (Australia). School of Physics. 10 Oct 1994. 42p. Sponsored by Natural Sciences and Engineering Research Council of Canada, Ottawa, ON (Canada). Grant CRG.900551. Order Number DE96602828. Source: OSTI; NTIS; INIS.

A broad set of observables are calculated for the $\pi^+ d \rightleftarrows pp$ reaction with a relatively simple meson-exchange isobar model. The comparison between the calculated results and experimental data (including spin observables), shows that the model gives an overall phenomenologically acceptable description of the reaction around the Δ resonance. The effects due to the inclusion of Galilei invariant (pseudovector) recoil term in the πNN vertex, of relativistic corrections to the ρ-exchange component of the ΔN transition potential, and of NN final state interaction in the $\pi^+ d \rightarrow p+p$ process are also discussed. It is estimated that the model is sufficiently simple to be extended to the case of pion absorption on other light nuclei, in particular ^3He (or tritium). 32 refs., 13 figs.

6624 Properties of Specific Particles and Resonances

Refer also to citation(s) 30360, 30935, 30965, 30991, 31002, 31010, 31011, 31012, 31013, 31017, 31045

31021 (BNL–62113) **Observation of the top quark.** Protopopescu, P. D0 Collaboration. Brookhaven National Lab., Upton, NY (United States). [1995]. 9p. Sponsored by USDOE, Washington, DC (United States). DOE Contract AC02-76CH00016. (CONF-9506125–4: 6. international symposium on heavy flavour physics, Pisa (Italy), 6-9 Jun 1995). Order Number DE95017157. Source: OSTI; NTIS; INIS; GPO Dep.

The DO collaboration reports on a search for the Standard Model top quark in $p\bar{p}$ collisions at $\sqrt{s} = 1.8$ TeV at the Fermilab Tevatron, with an integrated luminosity of approximately 50 pb^{-1}. We have searched for $t\bar{t}$ production in the dilepton and single-lepton decay channels, with and without tagging of b quark jets. We observe 17 events with an expected background of 3.8 ± 0.6 events. The probability for an upward fluctuation of the background to produce the observed signal is 2×10^{-6} (equivalent to 4.6 standard deviations). The kinematic properties of the excess events are consistent with top quark decay. We conclude that we have observed the top quark and measure its mass to be 199_{-21}^{+19} (stat.) ± 22 (syst.) GeV/c^2 and its production cross section to be 6.4 ± 2.2 pb.

31022 (FNAL/C–95/184-E) **Search for first and second generation leptoquarks at D0.** Abachi, S (Fermi National Accelerator Lab., Batavia, IL (United States)); Abbott, B.; Abolins, M. Fermi National Accelerator Lab., Batavia, IL (United States). Jul 1995. 13p. Sponsored by USDOE, Washington, DC (United States);National Science Foundation, Washington, DC (United States);CEA, 75 - Paris (France);Ministry of Science and Technology Policy (Russian Federation);Russian Atomic Energy Commission, Moscow (Russian Federa DOE Contract AC02-76CH03000. (CONF-950705–20: HEP 95: international Europhysics conference on high-energy physics, Brussels (Belgium), 21-27 Jul 1995). Order Number DE96000439. Source: OSTI; NTIS; INIS; GPO Dep.

A search for first and second generation pair produced scalar leptoquarks has been done with the DO detector at Fermilab's $p\bar{p}$ machine with $\sqrt{s} = 1.8$ TeV. Leptoquarks are assumed to be strictly generational; for example, a first generation leptoquark couples only to the electron, its neutrino, and the u and d quarks. 95% C.L. mass limits of 133 GeV/c^2 and 120 GeV/c^2 for respective 100% and 50% decay branching ratios to electron plus quark for first generation scalar leptoquarks have been published. The preliminary results of a search for second generation scalar leptoquarks in the absence of a signal are mass limits of 111 GeV/c^2 and 89 GeV/c^2 for 100% and 50% decay branching ratios to muon plus quark. A feature of these mass limits is that they are independent of the unknown coupling of the leptoquark to leptons and quarks. The detection for e^+e^- and e-p machines depends on the strength of this coupling.

31023 (FNAL/C–95/190-E) **B production at CDF.** Lukens, P.T. The CDF Collaboration. Fermi National Accelerator Lab., Batavia, IL (United States). Jul 1995. 11p. Sponsored by USDOE, Washington, DC (United States). DOE Contract AC02-76CH03000. (CONF-9505137–26: 10. topical workshop on proton-antiproton collider physics, Batavia, IL (United States), 9-13 May 1995). Order Number DE96000441. Source: OSTI; NTIS; INIS; GPO Dep.

Preliminary measurements of B meson cross sections, b quark cross sections, and $b\text{-}\bar{b}$ correlated cross sections are presented from the 1992—1993 data obtained at CDF. A search for new states in the 75 pb^{-1} sample obtained through early 1995 yields no evidence for $B_c \rightarrow J/\psi - \pi$ or $\Lambda_b \rightarrow J/\psi - \Lambda(1520)$.

31024 (FNAL/C–95/211-E) **Search for the top quark at D0 using multivariate methods.** Bhat, P.C. D0 Collaboration. Fermi National Accelerator Lab., Batavia, IL (United States). Jul 1995. 12p. Sponsored by USDOE, Washington, DC (United States). DOE Contract AC02-76CH03000. (CONF-9505137–12: 10. topical workshop on proton-antiproton collider physics, Batavia, IL (United States), 9-13 May 1995). Order Number DE95016648. Source: OSTI; NTIS; INIS; GPO Dep.

We report on the search for the top quark in $p\bar{p}$ collisions at the Fermilab Tevatron ($\sqrt{s} = 1.8$ TeV) in the di-lepton and lepton+jets channels using multivariate methods. An H-matrix analysis of the $e\mu$ data corresponding to an integrated luminosity of 13.5 ± 1.6 pb^{-1} yields one event whose likelihood to be a top quark event, assuming $m_{top} = 180$ GeV/c^2, is ten times more than that of WW and eighteen times more than that of $Z \rightarrow \tau\tau$. A neural network analysis of the e+jets channel using a data sample corresponding to an integrated luminosity of 47.9 ± 5.7 pb^{-1} shows an excess of events in the signal region and yields a cross-section for $t\bar{t}$ production of 6.7 ± 2.3 (stat.) pb, assuming a top mass of 200 GeV/c^2. An analysis of the e+jets data using the probability density estimation method yields a cross-section that is consistent with the above result.

31025 (FNAL/C–95/223-E) **$b\bar{b}$ production correlations, $b\bar{b}$ mixing and ϵ_B at CDF.** Abe, F. CDF Collaboration. Fermi National

Accelerator Lab., Batavia, IL (United States). Jul 1995. 5p. Sponsored by USDOE, Washington, DC (United States). DOE Contract AC02-76CH03000. (CONF-9503158–22: 30. Rencontres de Moriond on QCD and high energy interactions, Les Arcs (France), 19-26 Mar 1995). Order Number DE95017464. Source: OSTI; NTIS; INIS; GPO Dep.

We present preliminary measurements of $b\bar{b}$ production correlations, the average $B\bar{B}$ mixing, and a limit on the CP violating parameter ϵ_b using dimuon events from the dual semileptonic decay of $b\bar{b}$. Data used in this analysis was taken during the 1992–1993 CDF run of the Fermilab Tevatron collider with an integrated luminosity of 17.4 $\pm$ 0.6 pb^{-1}. The results on $b\bar{b}$ production correlations are compared to predictions of next-to-leading order QCD.

31026 (FNAL/C–95-237-E) **CDF top quark production and mass.** Incandela, J. CDF Collaboration. Fermi National Accelerator Lab., Batavia, IL (United States). 18 Jul 1995. 8p. Sponsored by USDOE, Washington, DC (United States). DOE Contract AC02-76CH03000. (CONF-9506125–1: 6. international symposium on heavy flavour physics, Pisa (Italy), 6-9 Jun 1995). Order Number DE95016487. Source: OSTI; NTIS; INIS; GPO Dep.

The top search in the dilepton and lepton plus jets channels with the Collider Detector at Fermilab is presented. The analysis uses a 67 pb^{-1} sample of $p\bar{p}$ collisions at 1.8 TeV. A 4.8σ excess of candidate events establishes the existence of the top quark. The $t\bar{t}$ production cross section is measured to be $\sigma_{t\bar{t}} = 7.6_{-2.0}{}^{+2.4}$ pb with branching Br(t $\rightarrow$ Wb) = $0.87_{-0.30}{}^{+0.13}$(stat) $_{-0.11}{}^{+0.13}$(syst). The measured mass is M_{top} = 176$\pm$8$\pm$10 GeV.

31027 (FNAL/C–95/288) **B_s mixing via ψK^*.** McBride, P. (Fermi National Accelerator Lab., Batavia, IL (United States)); Stone, S. Fermi National Accelerator Lab., Batavia, IL (United States). Aug 1995. 8p. Sponsored by USDOE, Washington, DC (United States). DOE Contract AC02-76CH03000. (CONF-9507180–1: 3. international workshop on B-physics at hadron machines, Oxford (United Kingdom), 10-14 Jul 1995). Order Number DE96000108. Source: OSTI; NTIS; INIS; GPO Dep.

The decay mode $B_s \rightarrow \psi K^*$ is suggested as a very good way to measure the B_s mixing parameter x_s. These decays can be gathered using a $\psi \rightarrow \ell^+\ell^-$ trigger. This final state has a well resolved four track decay vertex, useful for good time resolution and background rejection.

31028 (FNAL/C–162-E) **Top decay to lepton + jets: CDF B tags and cross section.** Incandela, J. CDF Collaboration. Fermi National Accelerator Lab., Batavia, IL (United States). 23 Jun 1995. 24p. Sponsored by USDOE, Washington, DC (United States). DOE Contract AC02-76CH03000. (CONF-9505137–8: 10. topical workshop on proton-antiproton collider physics, Batavia, IL (United States), 9-13 May 1995). Order Number DE95016488. Source: OSTI; NTIS; INIS; GPO Dep.

The top search in the lepton plus jets channel with the Collider Detector at Fermilab (CDF) is presented. The analysis uses a 67 pb^{-1} data sample of $p\bar{p}$ collisions at $\sqrt{s}$ = 1.8 TeV. Soft lepton tagging (SLT) and secondary vertex tagging (SVX) of b jets are used to reduce backgrounds. A significant excess of events over expected backgrounds is seen, and together with the excess of observed events in the dilepton (DIL) channel, firmly establish the existence of the top quark. Combining all channels, the $t\bar{t}$ production cross section is measured to be $\sigma_{t\bar{t}} = 7.6_{-2.0}{}^{+2.4}$ pb. The Branching of top to Wb is measured to be Br(t $\rightarrow$ Wb) = $0.87_{-0.30}{}^{+0.13}$(stat) $_{-0.11}{}^{+0.13}$(syst).

31029 (IC–95/117) **Electromagnetic detection of axions.** Hoang Ngoc Long (International Centre for Theoretical Physics, Trieste (Italy)); Tran, T.A.; Dang Van Soa. International Centre for Theoretical Physics, Trieste (Italy). Jun 1995. 7p. Order Number DE96602224. Source: OSTI; NTIS (US Sales Only); INIS.

Photon-to-axion conversions in the static electromagnetic fields are reconsidered in detail by using the Feynman diagram techniques. The differential cross sections are presented for the conversions in the presence of the electric field of the flat condenser as well as in the magnetic field of the solenoid. Based on our results a laboratory experiment for the production and the detection of the axions is described. This experiment will exploit the axion decay constant as well as the axion mass. (author). 15 refs.

31030 (LBL–37532) **Current trends in non-accelerator particle physics: 1, Neutrino mass and oscillation. 2, High energy neutrino astrophysics. 3, Detection of dark matter. 4, Search for strange quark matter. 5, Magnetic monopole searches.** He, Yudong (California Univ., Berkeley, CA (United States)). Lawrence Berkeley Lab., CA (United States). Jul 1995. 150p. Sponsored by USDOE, Washington, DC (United States). DOE Contract AC03-76SF00098. (CONF-9504206–1: Workshop on Tibet cosmic ray experiment and related physics topics, Beijing (China), 4-13 Apr 1995). Order Number DE96001118. Source: OSTI; NTIS; INIS; GPO Dep.

This report is a compilation of papers reflecting current trends in non-accelerator particle physics, corresponding to talks that its author was invited to present at the Workshop on Tibet Cosmic Ray Experiment and Related Physics Topics held in Beijing, China, April 4–13, 1995. The papers are entitled 'Neutrino Mass and Oscillation', 'High Energy Neutrino Astrophysics', 'Detection of Dark Matter', 'Search for Strange Quark Matter', and 'Magnetic Monopole Searches'. The report is introduced by a survey of the field and a brief description of each of the author's papers.

31031 (UCRL-JC–121562) **Experimental overview of axion searches.** van Bibber, K. Lawrence Livermore National Lab., CA (United States). 28 Jun 1995. 11p. Sponsored by USDOE, Washington, DC (United States). DOE Contract W-7405-ENG-48. (CONF-950183–5: Recontres de Moriond workshop, Villar-sur-Ollon (Switzerland), 21-28 Jan 1995). Order Number DE95016617. Source: OSTI; NTIS; GPO Dep.

Experimental methods to search for the "invisible axion" ($f_a \gg$ 250 GeV) are reviewed. The report focuses on the axion-photon coupling, both for laboratory experiments as well as those looking for stellar or cosmologically produced axions. The conclusion is that while the axion-photon mixing in principle would permit laboratory axion searches which are broadband in mass, in fact no such experiment could have the sensitivity to the axion, where $m_{axion} \approx m_{relic}$. The only experiments which promise to have any chance to find the axion are the microwave cavity experiments, which presume axions to constitute our galactic halo dark matter. The conversion of axions into a monochromatic microwave signal in a resonant circuit affords the experiment the extraordinary sensitivity required to see the axion, at the expense of being narrow-band in mass, i.e. a tuning experiment. Two such efforts are underway in the world.

31032 (UM-P–94/20) **The effective W boson approximation and heavy Higgs production at a photon-photon collider.** Ma, J.P. (Melbourne Univ., Parkville, VIC (Australia). Research Centre for High Energy Physics). Melbourne Univ., Parkville, VIC (Australia). School of Physics. [1995]. 7p. (OZ–94/07.). Order Number DE96602833. Source: OSTI; NTIS; INIS.

The inclusive production of single Higgs boson at a photon-phonon collider is studied under the effective W boson approximation. The W boson distribution in a photon is determined. The cross section is much larger than this from the photon-photon fusion and this means that a good opportunity of studying heavy Higgs boson can be provided at NLC, where photon beams may be obtained via Compton-backscattering of laser photons off the initial e^+ e^- beams. 8 refs., 1 fig.

31033 (UM-P–94/25) **Transverse polarization of top quarks produced at a photon-photon collider.** Bernreuther, W. (Inst. fuer Theoretische Physik, Physikzentrum RWTH, Aachen (Germany)); Ma, J.P.; McKellar, B.H.J. Melbourne Univ., Parkville, VIC (Australia). School of Physics. [1995]. 7p. (OZ–94/12; PITHA–94/17.). Order Number DE96602834. Source: OSTI; NTIS; INIS.

At future $\gamma\gamma$ colliders a massive production of tt-bar pairs is possible. This would allow a detailed investigation of the interactions involving the top quark. The authors propose some correlations which are sensitive to tt-bar final state interactions and compute the QCD and standard model Higgs boson contributions to these correlation. QCD-induced transverse polarization of top quarks is found to be sizeable and measurable at a high-energy e^+ e^- collider with an integrated luminosity of $10(fb)^{-1}$ which is converted into a photon collider by backscattering of laser photons. 16 refs.

31034 (UM-P–94/113) **More on random-lattice fermions.** Kieu, T.D. (Melbourne Univ., Parkville, VIC (Australia). School of Physics); Markham, J.F.; Paranavitane, C.B. Melbourne Univ., Parkville, VIC (Australia). School of Physics. [1995]. 3p. (RCHEP–94/31; IASSNS-HEP–94/105.). Order Number DE96602831. Source: OSTI; NTIS; INIS.

The lattice fermion determinants, in a given background gauge field, are evaluated for two different kinds of random lattices and compared to those of naive and wilson fermions in the continuum limit. While the fermion doubling is confirmed on one kind of lattices, there is positive evidence that it may be absent for the other, at least for vector interactions in two dimensions. Combined with previous studies, arbitrary randomness by itself is shown to be not a sufficient condition to remove the fermion doublers. 8 refs., 3 figs.

31035 (UM-P–94/133) **Magnetic monopole and finite photon mass: are they compatible.** Ignatiev, A.Y.; Joshi, G.C. Melbourne Univ., Parkville, VIC (Australia). School of Physics. 19 Dec 1994. 9p. Sponsored by Australian Research Council, Canberra, ACT (Australia). (RCHEP–94/37.). Order Number DE96602832. Source: OSTI; NTIS; INIS.

The role played by the gauge invariance for the existence of Dirac monopole is analysed. It is shown that the derivation of the Dirac quantization condition based on the angular momentum algebra cannot be generalized to the case of massive electrodynamics. The work revealed a new and important relation between the two fundamental facts: the masslessness (massiveness?) of the photons and the non-existence (existence?) of the magnetic monopole. Possible implications of this result are briefly discussed. 12 refs.

31036 (UM-P–95/23) **Gluon fragmentation into ^3P_J quarkonium.** Ma, J.P. Melbourne Univ., Parkville, VIC (Australia). School of Physics. 1995. 23p. Sponsored by Australian Research Council, Canberra, ACT (Australia). (RECHP–95/09.). Order Number DE96602835. Source: OSTI; NTIS; INIS.

The functions of the gluon fragmentation into ^3P_j quarkonium are calculated to order α^2_s. With the recent progress in analysing quarkonium systems in QCD it is possible show how the so called divergence in the limit of the zero-binding energy, which is related to P-wave quarkonia, is treated correctly in the case of fragmentation functions. The obtained fragmentation functions satisfy explicitly at the order of $\alpha\ ^2_s$ the Altarelli-Parisi equation and when $z \rightarrow 0$ they behave as z^{-1} as expected. 19 refs., 7 figs.

6630 Nuclear Physics

Refer also to citation(s) 29137, 29158, 29160, 30919

31037 (ANL–95/14) **Physics Division Annual Report, April 1, 1994–March 31, 1995.** Henning, W.F. Argonne National Lab., IL (United States). Aug 1995. 207p. Sponsored by USDOE, Washington, DC (United States). DOE Contract W-31109-ENG-38. Order Number DE96000985. Source: OSTI; NTIS; INIS; GPO Dep.

This report summarizes the research performed over the past year by the Argonne Physics Division in the areas of nuclear and atomic physics. The Division's programs in nuclear physics include operation of ATLAS as a national heavy-ion user facility and related accelerator development, nuclear structure research and reactions with beams of heavy ions, primarily at ATLAS but also using forefront instrumentation elsewhere, medium energy nuclear physics at SLAC, Fermilab, Novosibirsk, DESY and CEBAF, and nuclear theory. In atomic and molecular physics the research programs are directed towards studies of highly charged ions at ATLAS, and towards studies with synchrotron radiation, currently at the National Synchrotron Light Source at Brookhaven but also in preparation for the future program at the Advanced Photon Source at Argonne. Separate abstracts have been indexed for individual contributions to this report.

6631 Nuclear Structure

Refer also to citation(s) 30882, 31045, 31046, 31051, 31069, 31083

31038 (IAEA-NDS–104(rev.1)) **ENSDF. The Evaluated Nuclear Structure Data File maintained by the U.S. National Nuclear Data Center on behalf of the International Nuclear Structure and Decay Data Network, sponsored by the International Atomic Energy Agency.** IAEA-NDS–Documentation Series, IAEA-NDS–Documentation Series. Lemmel, H.D. (ed.). International Atomic Energy Agency, Vienna (Austria). Nuclear Data Section. Jul 1995. 20p. Order Number DE96602836. Source: OSTI; NTIS (US Sales Only); INIS.

The ENSDF database which contains evaluated experimental nuclear structure and decay data (nuclear half-lives, level energies, decay gamma-rays, etc.) is described. Online access to the database is provided by the major nuclear data centers. (author).

31039 (IAEA-NDS–161) **Chart of the nuclides. NUCHART for Windows version 1.2, Feb. 1995.** IAEA-NDS–Documentation Series, IAEA-NDS–Documentation Series. Osorio, V. (International Atomic Energy Agency, Vienna (Austria). Physics Section); Peraza, H. International Atomic Energy Agency, Vienna (Austria). Nuclear Data Section. Jun 1995. 3p. Order Number DE96602837. Source: OSTI; NTIS (US Sales Only); INIS.

The PC package NUCHART is described which displays nuclear decay data, including a search routine for assigning gamma-ray energies to radionuclides. The package is available upon request, costfree, from the IAEA. (author).

31040 (UM-P–95/27) **Tables of density dependent effective interactions at 200 MeV.** Dortmans, P.J.; Amos, K. Melbourne Univ., Parkville, VIC (Australia). School of Physics. 1995. 34p. Order Number DE96602838. Source: OSTI; NTIS; INIS.

Coordinate space effective nucleon-nucleon interactions are presented. They have been defined by optimal fits to select on- and half-off-of-the-energy shell t- and (density-dependent) g-matrices determined by solutions of the Lippmann-Schwinger (LS) and Brueckner-Bethe-Goldstone (BBG) equations, respectively. The Paris and BonnB nucleon-nucleon interactions were chosen as the initial forces from which solutions to the LS and (density dependent) BBG equations were made. The latter were solved for nuclear densities ranging from k_f=0.0 fm^{-1} (free) to k_f=1.5 fm $^{-1}$, above nuclear saturation. 14 refs., 16 tabs., 10 figs.

31041 (UM-P–95/29) **Tables of one body transition density matrix elements to select states in ^{12}C.** Karataglidis, S. Melbourne Univ., Parkville, VIC (Australia). School of Physics. 1995. 31p. Order Number DE96602841. Source: OSTI; NTIS; INIS.

One body density matrix elements (OBDME) for select transitions in ^{12}C have been calculated in a complete space, for positive parity final states, and a restricted shell model space for negative parity final states. These OBDMEs are given in a form that is suitable for use in analyses of elastic and inelastic scattering data. It is found that corrections such as core polarisation are naturally included in these large space shell model calculations. 17 refs., 24 tabs.

6632 Radioactivity and Electromagnetic Transitions (Excluding Fission)

Refer also to citation(s) 30954, 31038, 31039, 31046

31042 (IAEA-NDS–162) **PCNUDAT. A PC nuclear data program.** IAEA-NDS–Documentation Series, IAEA-NDS–Documentation Series. Kinsey, R.R. International Atomic Energy Agency, Vienna (Austria). Nuclear Data Section. Jun 1995. 5p. Order Number DE96602844. Source: OSTI; NTIS (US Sales Only); INIS.

The PC program PCNUDAT is described which displays nuclear radioactive decay data and thermal cross-section data. It requires 44 Megabytes of disk space and can be obtained through INTERNET FTP from the U.S. National Nuclear Data Center. (author).

31043 (IC–95/174) **Fine structure in cluster decays (^{4}He, ^{14}C, ^{20}O and ^{34}Si).** Dumitrescu, O. International Centre for Theoretical Physics, Trieste (Italy). Jul 1995. 12p. Order Number DE96602246. Source: OSTI; NTIS (US Sales Only); INIS.

Within the one level R-matrix approach several hindrance factors for the radioactive decays in which are emitted ^{4}He, ^{14}C, ^{20}O and ^{34}Si atomic nuclei are calculated. The interior wave functions are supposed to be given by the recently proposed enlarged superfluid model, an extension of the JINR - Dubna's quasiparticle phonon

nuclear model. The spectroscopic factors are expanded in terms of products of cluster overlaps and intrinsic overlap integrals. The cluster overlaps are equivalents of the generalized coefficients of fractional parentage, while for the intrinsic overlap integrals we construct a model, which is an extension of the usual models for simple particle decay such as deuteron, triton and alpha decay. The exterior wave functions are calculated from a cluster - nucleus double - folding model potential obtained with the M3Y interaction. As examples of the cluster decay fine structure we analyzed the particular cases of α - decay of ^{241}Am, ^{243}Cm and ^{255}Fm ^{14}C - decay of ^{223}Ra, ^{20}O - decay of ^{229}Th and ^{255}Fm and ^{34}Si - decay of ^{243}Cm. A relatively good agreement with the experimental data is obtained especially in the case of α - decay fine structure. (author). 25 refs, 1 tab.

31044 (PNL-SA–25608) **A general algorithm for radioactive decay with branching and loss from a medium.** Strenge, D.L. Pacific Northwest Lab., Richland, WA (United States). Jul 1995. 9p. Sponsored by USDOE, Washington, DC (United States). DOE Contract AC06-76RL01830. (CONF-950702–2: Joint meeting of the American Association of Physicists in Medicine and the Health Physics Society, Boston, MA (United States), 23-27 Jul 1995). Order Number DE95016813. Source: OSTI; NTIS; INIS; GPO Dep.

Many areas in the field of health physics require evaluation of the change of radionuclide quantity in a medium with time. A general solution to first-order compartmental models is presented in this paper for application to systems consisting of one physical medium that contains any number of radionuclide decay chain members. The general analytical solution to the problem is first described mathematically, and then extended to four applications: (1) evaluation of the quantity of radionuclides as a function of time, (2) evaluation of the time integral of the quantity during a time period, (3) evaluation of the amount in a medium as a function of time following deposition at a constant rate, and (4) evaluation of the time integral of the amount in a medium after deposition at a constant rate for a time. The solution can be applied to any system involving physical transfers from the medium and radioactive chain decay with branching in the medium. The general solution is presented for quantities expressed in units of atoms and activity. Unlike many earlier mathematical solutions, this solution includes chain decay with branching explicitly in the equations.

6633 Nuclear Reactions and Scattering, General

Refer also to citation(s) 31063, 31066

31045 (DOE/ER/40150–284) **Spin degrees of freedom in electromagnetic nuclear physics.** Burkert, V.D. (CEBAF, Newport News, VA (United States)). Southeastern Universities Research Association, Inc., Newport News, VA (United States). Continuous Electron Beam Accelerator Facility. 26 Oct 1994. 146p. Sponsored by USDOE, Washington, DC (United States). DOE Contract AC05-84ER40150. (CEBAF-R–94-004; CONF-9410385–: Spin degrees of freedom in electromagnetic nuclear physics, Williamsburg, VA (United States), 26 Oct 1994). Order Number DE96000102. Source: OSTI; NTIS; INIS; GPO Dep.

This report contains papers on the following topics: spin polarization in electromagnetic physics at intermediate energies; solid polarized targets; polarized electron sources; measurement of the proton spin structure function; measurement of proton and neutron spin structure at SLAC; spin dependent scattering and the quark content of nucleons; physics of Q squared-dependence in the nucleon's structure function sum rule; electromagnetic spin structure response of nucleons in nuclei; polarimetry in the few Gev region; and polarized photons for nuclear and particle physics. These paper have been cataloged separately elsewhere.

31046 (IC–95/139) **Neutral currents in low energy nuclear physics processes.** Dumitrescu, O. International Centre for Theoretical Physics, Trieste (Italy). Jul 1995. 73p. Order Number DE96602251. Source: OSTI; NTIS (US Sales Only); INIS.

The possibility to extract from the experiment the necessary informations concerning the neutral current contributions to the structure of the weak interactions that violate the parity conservation low is investigated. The parity nonconservation (PNC) induced by weak hadron - hadron interactions investigated via low energy nuclear physics processes is reviewed. The low energy nuclear physics processes considered here are: the resonance nuclear scattering and reactions induced by polarized projectiles such as protons and deuterons, emission of polarized gamma rays from oriented and nonoriented nuclei and parity forbidden alpha decay. Some comments on PNC nucleon - nucleon (PNC - NN) interaction are presented. Explicit expressions for some PNC observables are rederived. Applications for specific scattering, reaction and decay modes are done. New experiments are proposed. (author). 16 refs, 2 figs, 10 tabs.

31047 (INS-J–180) **Towards the unified understanding of elastic and inelastic scattering and transfer reactions. Proceedings.** Yamaguchi, Sinichiro (ed.) (Osaka Univ., Ibaraki (Japan). Research Center for Nuclear Physics). Tokyo Univ., Tanashi (Japan). Inst. for Nuclear Study. Apr 1995. 67p. (CONF-9401125–: Workshop on towards the unified understanding of elastic and inelastic scattering and transfer reactions, Tanashi (Japan), 6-8 Jan 1994). Order Number DE96701435. Source: OSTI; NTIS; INIS.

This issue is the collection of the papers presented at the title meeting. The 10 of the presented papers are indexed individually. (J.P.N.).

31048 (JAERI-Conf–95-004) **Proceedings of the second symposium on joint spectroscopy experiments utilizing JAERI Tandem-booster accelerator.** Oshima, Masumi (Japan Atomic Energy Research Inst., Tokai, Ibaraki (Japan). Tokai Research Establishment); Morikawa, Tsuneyasu; Hatsukawa, Yuichi; Ishii, Tetsuro; Kidera, Masanori; Ikezoe, Hiroshi (eds.). Japan Atomic Energy Research Inst., Tokyo (Japan). Mar 1995. 111p. (In Japanese, English). (CONF-9407199–: 2. symposium on joint spectroscopy experiments utilizing JAERI Tandem-booster accelerator, Tokai (Japan), 25-26 Jul 1994). Order Number DE96701432. Source: OSTI; NTIS; INIS.

This issue is the collection of the papers presented at the title meeting. The 22 of the presented papers are indexed individually. (J.P.N.).

31049 (UM-P–94/31) **Two body potentials from quantal inversion of differential cross section data.** Amos, K.; Allen, L.J.; Lun, D.R.; Steward, C. Melbourne Univ., Parkville, VIC (Australia). School of Physics. [1995]. 4p. Order Number DE96602847. Source: OSTI; NTIS; INIS.

Quantal inverse scattering theory has been applied to the analysis of elastic scattering differential cross-section data from nuclear heavy ion, nucleon-nucleon, atom-atom and electron-molecule collisions. For all such systems, application has led to central local potentials whose use in finding solutions of the radial Schroedinger equations give excellent fits to the measured data. 5 refs., 1 fig.

31050 (UM-P–95/01) **Problems in the links between scattering data and interaction potentials.** Amos, K. Melbourne Univ., Parkville, VIC (Australia). School of Physics. 1995. 28p. Order Number DE96602848. Source: OSTI; NTIS; INIS.

Dedicated to the memory of Professor Harry Fiedeldey from the University of South Africa.

The scattering function is of paramount importance in any approaches by which quantitative information on the interaction between colliding quantal systems of nuclear, atomic or molecular type, may be sought from measured, elastic scattering data. Therein there are two possible spectral parameters, the energy and the angular momentum. Most experimental results suggest use of fixed energy and variable angular momentum schemes. Such fixed energy data and their analyses are the subject of this report, with particular emphasis placed upon the problems of the link between data and the scattering function. 18 figs.

31051 (UM-P–95/02) **An evaluation of diverse methods of obtaining effective Schroedinger interaction potentials for elastic scattering.** Amos, K. (Melbourne Univ., Parkville, VIC (Australia). School of Physics); Allen, L.J.; Steward, C.; Hodgson, P.E.; Sofianos, S.A. Melbourne Univ., Parkville, VIC (Australia). School of Physics. 1995. 9p. Order Number DE96602849. Source: OSTI; NTIS; INIS.

Direct solution of the Schroedinger equation and inversion methods of analysis of elastic scattering data are considered to evaluate the information that they can provide about the physical interaction between colliding nuclear particles. It was found that both optical model and inversion methods based upon inverse scattering theories are subject to ambiguities. Therefore, it is essential that elastic scattering data analyses are consistent with microscopic calculations of the potential. 25 refs.

6634 Specific Nuclear Reactions and Scattering

Refer also to citation(s) 29498, 29499, 29500, 29501, 30284, 30528, 30529, 30530, 30531, 30532, 30954, 30993, 30994, 31009, 31020, 31030, 31049, 31098

31052 (BNL–34518-Rev.12/94) **AGS experiments: 1992, 1993, 1994. Revision December 1994.** Depken, J.C. Brookhaven National Lab., Upton, NY (United States). Mar 1995. 187p. Sponsored by USDOE, Washington, DC (United States). DOE Contract AC02-76CH00016. Order Number DE95017556. Source: OSTI; NTIS; INIS; GPO Dep.

This document contains listings and two page summaries for experiments run at the GAS for 1992–1994. Listings are also given for publications and experimenters. A working copy of the 1995–1996 experiment schedule is also included.

31053 (IAEA-NDS–100(rev.6)) **ENDF/B-6. The U.S. Evaluated Nuclear Data Library for neutron reaction data by the US National Nuclear Data Center - 1990 including revisions up to May 1995 - Summary of contents.** IAEA-NDS–Documentation Series, IAEA-NDS–Documentation Series. Lemmel, H.D. International Atomic Energy Agency, Vienna (Austria). Nuclear Data Section. Jun 1995. 28p. Order Number DE96602858. Source: OSTI; NTIS (US Sales Only); INIS.

This document summarizes the contents of the general-purpose neutron data file of ENDF/B-6, the U.S. Evaluated Nuclear Data Library, including supplements and revisions up to May 1995. The data library is in ENDF-6 format, either in the basic compact form with resonance parameters (50 Megabytes), or in point data form where resonance parameters have been converted to cross-sections (300 Megabytes). The entire library or retrievals of selected materials are available on magnetic tape from the IAEA Nuclear Data Section free of charge. The library is also available online within NDIS, the Nuclear Data Information System. (author).

31054 (IAEA-NDS–106(rev.3)) **ENDF/B-6 FPY. The ENDF/B-6 fission-product yield sublibraries. Released by the U.S. National Nuclear Data Center in 1991, including revisions up to May 1995. Summary documentation.** IAEA-NDS–Documentation Series, IAEA-NDS–Documentation Series. Lemmel, H.D. International Atomic Energy Agency, Vienna (Austria). Nuclear Data Section. Jun 1995. 3p. Order Number DE96602878. Source: OSTI; NTIS (US Sales Only); INIS.

The contents and the documentation of the ENDF/B-6 fission-product yield sublibraries which were released in 1991 and updated in 1993 and 1995, are summarized. Copies of the data libraries are available on magnetic tape or PC diskettes from the IAEA Nuclear Data Section, costfree upon request. (author).

31055 (IAEA-NDS–107(rev.10)) **Index to BROND-2, CENDL-2, ENDF/B-6, JEF-2, JENDL-3, IRDF, EFF-2.4 and FENDL/E.** IAEA-NDS–Documentation Series, IAEA-NDS–Documentation Series. Lemmel, H.D. International Atomic Energy Agency, Vienna (Austria). Nuclear Data Section. Jun 1995. 19p. Order Number DE96602859. Source: OSTI; NTIS (US Sales Only); INIS.

This document contains a brief index to the five main data libraries for evaluated neutron reaction data, including BROND-2 from USSR (1992 update), CENDL-2 from China (1993 version), ENDF/B-6 from USA (including 1995 revisions), JEF-2 from OECD/NEA (1992) and JENDL-3.2 (1994) from Japan. It also indexes IRDF-90, the International Reactor Dosimetry File from IAEA (1993 update), and the available data libraries for fission-product yield data, and two data libraries for fusion applications, i.e. EFF-2.4 (EC) and FENDL/E (IAEA). (author).

31056 (IAEA-NDS–128(rev.1)) **FENDL/E. Evaluated nuclear data library of neutron nuclear interaction cross-sections and photon production cross-sections and photon-atom interaction cross sections for fusion applications. Version 1.0 of May 1994.** IAEA-NDS–Documentation Series, IAEA-NDS–Documentation Series. Ganesan, S.; McLaughlin, P.K. International Atomic Energy Agency, Vienna (Austria). Nuclear Data Section. Jul 1995. 10p. Order Number DE96602860. Source: OSTI; NTIS (US Sales Only); INIS.

This document presents the description of a physical tape containing the basic evaluated nuclear data library of neutron nuclear interaction cross-sections and photon production cross-sections and photon-atom interaction cross-sections for fusion applications. It is part of FENDL, the evaluated nuclear data library for fusion applications. The nuclear data are available cost-free for distribution to interested scientists upon request. The data can also be retrieved by the user via online access through international computer networks. (author). 12 refs, 2 tabs.

31057 (IAEA-NDS–129(rev.2)) **FENDL/MG-1.0. Library of multigroup cross sections in GENDF and MATXS format for neutron-photon transport calculations generated by R.R. MacFarlane by processing FENDL/E-1. Summary documentation.** IAEA-NDS–Documentation Series, IAEA-NDS–Documentation Series. Ganesan, S.; Wienke, H. International Atomic Energy Agency, Vienna (Austria). Nuclear Data Section. Apr 1995. 15p. Order Number DE96602861. Source: OSTI; NTIS (US Sales Only); INIS.

Selected neutron reaction nuclear data evaluations and photon-atomic interaction cross section libraries for elements of interest to the IAEA's program on Fusion Evaluated Nuclear Data Library (FENDL) have been processed into GENDF and MATXS format using the NJOY system by R.E. MacFarlane. This document summarizes the resulting multigroup data library FENDL/MG-1.0. The data are available costfree, upon request from the IAEA Nuclear Data Section, online or on magnetic tape. (author). 6 refs.

31058 (IAEA-NDS–136(rev.1)) **MENDL-2. Neutron reaction data library for nuclear activation and transmutation at intermediate energies. Summary description.** IAEA-NDS–Documentation Series, IAEA-NDS–Documentation Series. Lemmel, H.D. International Atomic Energy Agency, Vienna (Austria). Nuclear Data Section. Jul 1995. 6p. Order Number DE96602862. Source: OSTI; NTIS (US Sales Only); INIS.

The MENDL-2 nuclear data library contains for 505 stable and unstable target nuclides production cross-sections for the formation of radioactive product nuclides for incident neutrons with energies up to 100 MeV. The nuclides included cover the range from 13-Al-26 to 84-Po-210 with half-lives larger than one day. The data library is available from the IAEA Nuclear Data Section, costfree, upon request. (author). Refs.

31059 (IAEA-NDS–137(rev.2)) **ADL-3. Neutron activation data library. Summary documentation.** IAEA-NDS–Documentation Series, IAEA-NDS–Documentation Series. Pashchenko, A.B.; Lemmel, H.D. International Atomic Energy Agency, Vienna (Austria). Nuclear Data Section. Jul 1995. 5p. Order Number DE96602863. Source: OSTI; NTIS (US Sales Only); INIS.

This document summarizes a neutron activation cross-section data library containing more than 20,000 excitation functions for neutron energies up to 20 MeV. The data are available from the IAEA Nuclear Data Section on magnetic tape or online via INTERNET by FTP command. (author).

31060 (IAEA-NDS–143) **WIND. Neutron nuclear data library for isotopes of U, Np, Pu up to 100 MeV with one file of proton nuclear data for U-238. Summary documentation.** IAEA-NDS–Documentation Series, IAEA-NDS–Documentation Series. Lemmel, H.D. International Atomic Energy Agency, Vienna (Austria). Nuclear Data Section. Jul 1995. 20p. Order Number DE96602864. Source: OSTI; NTIS (US Sales Only); INIS.

The WIND nuclear data library ("Waste Incineration Nuclear Data") contains evaluated data of neutron induced fission and threshold reactions for isotopes of U, Np, and Pu, and one file of proton induced reactions for U-238, in the energy range up to 100 MeV, primarily designed for the study of incineration of longlived

radioactive materials. The data library is available from the IAEA Nuclear Data Section, costfree, upon request. (author).

31061 (IAEA-NDS–169(rev.2)) **FENDL/MC-1.0. Library of continuous energy cross sections in ACE format for neutron-photon transport calculations with the Monte Carlo N-particle Transport Code system MCNP 4A. Generated by R.E. MacFarlane by processing FENDL/E-1. Summary documentation.** IAEA-NDS–Documentation Series, IAEA-NDS–Documentation Series. Ganesan, S.; Wienke, H. International Atomic Energy Agency, Vienna (Austria). Nuclear Data Section. Mar 1995. 13p. Order Number DE96602865. Source: OSTI; NTIS (US Sales Only); INIS.

Selected neutron reaction nuclear data evaluations for elements of interest to the IAEA's program on Fusion Evaluated Nuclear Data Library (FENDL) have been processed into ACE format using the NJOY system by R.E. MacFarlane. This document summarizes the resulting continuous energy cross section data library FENDL/MC-1.0. The data are available cost free, upon request from the IAEA Nuclear Data Section, online or on magnetic tape. (author).

31062 (IAEA-NDS–170) **EFF-2.4. The European Fusion File, 1994 including revisions up to May 1995. Summary documentation.** IAEA-NDS–Documentation Series, IAEA-NDS–Documentation Series. Lemmel, H.D. International Atomic Energy Agency, Vienna (Austria). Nuclear Data Section. Jun 1995. 6p. Order Number DE96602866. Source: OSTI; NTIS (US Sales Only); INIS.

A summary documentation of EFF-2.4, the European evaluated neutron nuclear data library for selected materials needed in fusion applications, is given. The data library is available from the IAEA Nuclear Data Section on magnetic tape, costfree upon request, or online from the NEA Data Bank. (author).

31063 (IC–95/90) **An inversion solution to heavy-ion optical model potential at intermediate energies.** Fayyad, H.M. (Al-Fateh Univ., Tripoli (Libyan Arab Jamahiriya). Dept. of Physics); Rihan, T.H.; Awin, A.M. International Centre for Theoretical Physics, Trieste (Italy). May 1995. 33p. Order Number DE96602273. Source: OSTI; NTIS (US Sales Only); INIS.

In this paper, we show by solving the inversion problem at high energies that the fundamental McIntyre parametrization of the S-matrix, for heavy-ion collision, will correspond to a Woods-Saxon type optical model potential. The parameters of such a Woods-Saxon's potential are directly related to the corresponding parameters of the McIntyre parametrization. The inversion solution results were tested for the available experimental data and were found to be in good agreement. (author). 12 refs, 4 figs.

31064 (IC–95/110) **Strangeness production and thermal freeze-out conditions in S-S collisions at 200 GeV/A.** Uddin, S. International Centre for Theoretical Physics, Trieste (Italy). Jun 1995. 19p. Order Number DE96602272. Source: OSTI; NTIS (US Sales Only); INIS.

In the framework of our recently proposed model for the hadronic gas, the CERN NA35 collaboration data from central S-S collisions at 200 GeV/A are analyzed. The model which provides a thermodynamically consistent equation of state of hot hadronic matter consisting of hadrons with hard-core repulsion, is used to analyze the relative and absolute abundance of strange (antistrange) particles. The analysis yields information regarding the thermal parameters at freeze-out viz. The light quark fugacity λ_q, the strange quark fugacity λ_s, the temperature T and the strangeness phase-space saturation factor γ_s. (author). 27 refs, 4 tabs.

31065 (INDC(PAK)–009) **Systematics of (n,p) and (n,α) cross sections for 14 MeV neutrons on the basis of statistical model.** Gul, K. (Pakistan Inst. of Nuclear Science and Technology, Islamabad (Pakistan). Scientific Information Div.). International Atomic Energy Agency, Vienna (Austria). International Nuclear Data Committee. Jul 1995. 40p. Order Number DE96602255. Source: OSTI; NTIS (US Sales Only); INIS.

The systematic behaviour of (n,p) and (n,α) cross sections for 14 MeV neutrons has been investigated using Weisskopf formulation of statistical model for nuclear reactions and introducing an exponential term that takes care of the suppression of charged particle emission by Coulomb barrier. The dependence of the values of various coefficients of the physical parameters of the systematics on the level density parameter is also investigated. An intercomparison of the predictions of the present systematics with those of the systematics based on asymmetry parameter, and measured values is provided. (author). 44 refs, 5 figs, 10 tabs.

31066 (INDC(PAK)–010) **A computer code for nuclear optical model calculations.** Gul, K. (Pakistan Inst. of Nuclear Science and Technology, Islamabad (Pakistan). Scientific Information Div.). International Atomic Energy Agency, Vienna (Austria). International Nuclear Data Committee. Jul 1995. 26p. Order Number DE96602256. Source: OSTI; NTIS (US Sales Only); INIS.

The report describes the details of the spherical optical model code developed by the author. The details include mathematical formulations and their methods of solutions. The code computes differential elastic scattering cross sections for neutrons and protons, nuclear polarization, Mott-Schwinger polarization and total cross sections for neutrons. The code also gives volume integrals of potentials and average values of potential radii, potential scattering length and strength functions. A comparison of the calculations of the present code with those done using other codes is also provided. (author). 22 refs, 3 tabs.

31067 (INDC(PAK)–011) **A computer code based on Hauser-Feshbach and Moldauer theory for nuclear cross section calculations.** Gul, K. (Pakistan Inst. of Nuclear Science and Technology, Islamabad (Pakistan). Scientific Information Div.). International Atomic Energy Agency, Vienna (Austria). International Nuclear Data Committee. Jul 1995. 20p. Order Number DE96602257. Source: OSTI; NTIS (US Sales Only); INIS.

The report describes a computer code which is based on Hauser-Feshbach and Moldauer theory. It considers the calculation of compound elastic, inelastic, (n,p) and (n,α) cross sections as one-step process and (n,2n), (n,np) and (n,pn) cross sections as a two-step process. The competition of photons with particles for emission is included in the second step of the reaction only. The available calculations of the elastic and inelastic scattering cross sections with similar codes are compared with the calculations based on the present code. (author). 26 refs, 3 tabs.

31068 (LA-UR–95-2067) **Adaptation cf a nucleon-nucleus elastic scattering model for LAHET™.** Prael, R.E.; Madland, D.G. Los Alamos National Lab., NM (United States). [1995]. 6p. Sponsored by Department of Defense, Washington, DC (United States). DOE Contract W-7405-ENG-36. (CONF-951006–21: Winter meeting of the American Nuclear Society, San Francisco, CA (United States), 29 Oct - 1 nov 1995). Order Number DE95015276. Source: OSTI; NTIS; INIS; GPO Dep.

The LAHET Monte Carlo code for the transport and interaction of nucleons, pions, muons, light ions, and antinucleons has been upgraded by the addition of an elastic scattering model for neutrons above 15 MeV and protons above 50 MeV. Earlier elastic scattering in LAHET has been limited to neutrons below 100 MeV, using a library of elastic optical-model cross sections generated using the Bechetti-Greenlees potential. The new methodology has been adapted from the HERMES code. However, the sampling algorithm for the center-of-mass scattering angle has been completely rewritten, and the elastic cross section data has been replaced below 400 MeV. The new method is viewed as an intermediate step in the effort to provide a library of both elastic and non-elastic cross sections from a global optical-model potential for LAHET usage.

31069 (LA-UR–95-3329) **An update on measurements of helium-production reactions with a spallation neutron source.** Haight, R.C. (and others); Bateman, F.B.; Chadwick, M.B. Los Alamos National Lab., NM (United States). [1995]. 12p. Sponsored by USDOE, Washington, DC (United States). DOE Contract W-7405-ENG-36. (CONF-9509234–1: IAEA research/improvement of measurements, theoretical computations and evaluations of neutron-induced helium production cross sections, Sendai (Japan), 25-29 Sep 1995). Order Number DE96001470. Source: OSTI; NTIS; INIS; GPO Dep.

This report gives the status, updated since the last Research Coordination Meeting, of alpha-particle production cross sections, emission spectra and angular distributions which we are measuring at the spallation source of fast neutrons at the Los Alamos Meson Physics Facility (LAMPF). Detectors at angles of 30, 60, 90 and

135° are used to identify alpha particles, measure their energy spectra, and indicate the time-of-flight, and hence the energy, of the neutrons inducing the reaction. The useful neutron energy ranges from less than 1 MeV to approximately 50 MeV for the present experimental setup. Targets under study at present include C, N, 0, ^{27}Al, Si, ^{51}V, ^{56}Fe, ^{59}CO, ^{58,60}Ni, ^{89}Y and ^{93}Nb. Data for ^{59}Co have been re-analyzed. The results illustrate the capabilities of the approach, agreement with literature values, and comparisons with nuclear reaction model calculations.

31070 (LA-UR–95-17922, pp. 672-680) **Spallation studies at Saturne.** Frehaut, J. (Centre d'Etudes de Bruyeres-le-Chatel (France)). Los Alamos National Lab., NM (United States). [1995]. (CONF-9407103–: International conference on accelerator-driven transmutation technologies and applications, Las Vegas, NV (United States), 25 Jul - 1 aug 1994). In *AIP conference on accelerator driven transmutation technologies and applications, Los Vegas, Nevada, July 25-29, 1994.* 958p. Order Number DE95014018. Source: OSTI; NTIS; INIS.

SATURNE is a synchrotron accelerator which can deliver particles of momentum P and charge Z up to P/Z = 4 GeV/c. Monokinetic neutron beams of momentum up to 2 GeV/c can be produced. The spallation studies deal with measurements of: (i) differential neutron production cross sections from thin targets, (ii) neutron multiplicity distribution for proton and ^{3}He induced reactions, and (iii) nuclide production in thin target. Measurements on thick or composite targets are under consideration.

31071 (LA-UR–95-17922, pp. 681-688) **LANL sunnyside experiment: Study of neutron production in accelerator-driven targets.** Morgan, G. (Los Alamos National Laboratory, NM (United States)); Butler, G.; Cappiello, M. Los Alamos National Lab., NM (United States). [1995]. (CONF-9407103–: International conference on accelerator-driven transmutation technologies and applications, Las Vegas, NV (United States), 25 Jul - 1 aug 1994). In *AIP conference on accelerator driven transmutation technologies and applications, Los Vegas, Nevada, July 25-29, 1994.* 958p. Order Number DE95014018. Source: OSTI; NTIS; INIS.

Measurements have been made of the neutron production in prototypic targets for accelerator driven systems. Studies were conducted on four target assemblies containing lead, lithium, tungsten, and a thorium-salt mixture. Integral data on total neutron production were obtained as well as more differential data on neutron leakage and neutron flux profiles in the blanket/moderator region. Data analysis on total neutron production is complete and shows excellent agreement with calculations using the LAHET/MCNP code system.

31072 (LA-UR–95-17922, pp. 689) **800-MeV proton irradiation of thorium and depleted uranium targets.** Russell, G.J. (Los Alamos National Laboratory, NM (United States)); Brun, T.O.; Pitcher, E.J. Los Alamos National Lab., NM (United States). [1995]. (CONF-9407103–: International conference on accelerator-driven transmutation technologies and applications, Las Vegas, NV (United States), 25 Jul - 1 aug 1994). In *AIP conference on accelerator driven transmutation technologies and applications, Los Vegas, Nevada, July 25-29, 1994.* 958p. Order Number DE95014018. Source: OSTI; NTIS; INIS.

As part of the Los Alamos Fertile-to-Fissile-Conversion (FERFICON) program in the late 1980's, thick targets of the fertile materials thorium and depleted uranium were bombarded by 800-MeV protons to produce the fissile materials ^{233}U and ^{239}Pu, respectively. The amount of ^{233}U made was determined by measuring the ^{233}Pa activity, and the yield of ^{239}Pu was deduced by measuring the activity of ^{239}Np. For the thorium target, 4 spallation products and 34 fission products were also measured. For the depleted uranium target, 3 spallation products and 16 fission products were also measured. The number of fissions in each target was deduced from fission product mass-yield curves. In actuality, axial distributions of the products were measured, and the distributions were then integrated over the target volume to obtain the total number of products for each reaction.

31073 (LA-UR–95-17922, pp. 690) **ATW neutron spectrum measurements at LAMPF.** Butler, G.W. (Los Alamos National Laboratory, NM (United States)); Littleton, P.E.; Morgan, G.L. Los Alamos National Lab., NM (United States). [1995]. (CONF-9407103–: International conference on accelerator-driven transmutation technologies and applications, Las Vegas, NV (United States), 25 Jul - 1 aug 1994). In *AIP conference on accelerator driven transmutation technologies and applications, Los Vegas, Nevada, July 25-29, 1994.* 958p. Order Number DE95014018. Source: OSTI; NTIS; INIS.

Accelerator transmutation of waste (ATW) is a proposal to use a high flux of accelerator-produced thermalized neutrons to transmute both fission product and higher actinide commercial nuclear waste into stable or short-lived radioactive species in order to avoid long-term storage of nuclear waste. At LAMPF the authors recently performed experiments that were designed to measure the spectrum of neutrons produced per incident proton for full-scale proposed ATW targets of lead and lithium. The neutrons produced in such targets have a spectrum of energies that extends up to the energy of the incident proton beam, but the distribution peaks between 1 and 5 MeV. Transmutation reactions and fission of actinides are most efficient when the neutron energy is below a few eV, so the target must be surrounded by a non-absorbing material (blanket) to produce additional neutrons and reduce the energy of high energy neutrons without loss. The experiments with the lead target, 25 cm diameter by 40 cm long, were conducted with 800 MeV protons, while those with the lithium target, 25 cm diameter by 175 cm long, were conducted with 400 MeV protons. The blanket in both sets of experiments was a 60 cm diameter by 200 cm long annulus of lead that surrounded the target. Surrounding the blanket was a steel water tank with dimensions of 250 cm diameter by 300 cm long that simulated the transmutation region. A small sample pipe penetrated the length of the lead blanket and other sample pipes penetrated the length of the water tank at different radii from the beam axis so that the neutron spectra at different locations could be measured by foil activation. After irradiation the activated foil sets were extracted and counted with calibrated high resolution germanium gamma ray detectors at the Los Alamos nuclear chemistry counting facility.

31074 (LA-UR–95-17922, pp. 698-701) **Cross-section activation measurement for U-238 through protons and deuterons in energy interval 10-14 MeV.** Guzhovskii, B.Y. (Russia Federal Nuclear Centre, Arzamas (Russian Federation)); Abramovich, S.N.; Zvenigorodskii, A.G. Los Alamos National Lab., NM (United States). [1995]. (CONF-9407103–: International conference on accelerator-driven transmutation technologies and applications, Las Vegas, NV (United States), 25 Jul - 1 aug 1994). In *AIP conference on accelerator driven transmutation technologies and applications, Los Vegas, Nevada, July 25-29, 1994.* 958p. Order Number DE95014018. Source: OSTI; NTIS; INIS.

There were presented results of cross-section measurements for nuclear reactions ^{238}U(p,n)^{238}Np, ^{238}U(d,2n)^{238}Np, ^{238}U(d,t)^{237}U, ^{238}U(d,p)^{239}U, and ^{238}U(d,n)^{239}Np. Interval of projectile energy was 10-14 MeV. For measurements of cross-sections it was used the activatio methods. The registration of β- and γ-activity was made with using of plastic scintillation detector and Ge(Li)-detector.

31075 (LA-UR–95-17922, pp. 826-832) **Measured radionuclide production from copper, gold and lead spallation targets.** Parish, T.A. (Texas A & M Univ., College Station, TX (United States)); Belian, A.P. Los Alamos National Lab., NM (United States). [1995]. (CONF-9407103–: International conference on accelerator-driven transmutation technologies and applications, Las Vegas, NV (United States), 25 Jul - 1 aug 1994). In *AIP conference on accelerator driven transmutation technologies and applications, Los Vegas, Nevada, July 25-29, 1994.* 958p. Order Number DE95014018. Source: OSTI; NTIS; INIS.

Spallation target materials are chosen so as to produce large numbers of neutrons while at the same time avoiding the creation of long-lived radioactive wastes. While there has been considerable research to determine the number of neutrons produced per incident particle for various target materials, there has been less effort to precisely quantify the types and amounts of radionuclides produced. Accurate knowledge of the radioactive species produced by spallation reactions is important for specifying waste disposal criteria for targets. In order to verify the production rates calculated by

LAHET, a study has been conducted using the Texas A&M University (TAMU) Cyclotron to measure radionuclide yields from copper, gold, and lead targets.

31076 (LA-UR–95-17922, pp. 833-834) **Neutron data library for transactinides at energies up to 100 MeV.** Korovin, Y.A. (Obninsk Institute of Nuclear Power Engineering (Russian Federation)); Artisyuk, V.V.; Konobeyev, A.Y. Los Alamos National Lab., NM (United States). [1995]. (CONF-9407103–: International conference on accelerator-driven transmutation technologies and applications, Las Vegas, NV (United States), 25 Jul - 1 aug 1994). In *AIP conference on accelerator driven transmutation technologies and applications, Los Vegas, Nevada, July 25-29, 1994.* 958p. Order Number DE95014018. Source: OSTI; NTIS; INIS.

New neutron data library for transactinides is briefly described. The library includes evaluated cross-sections for fission and threshold neutron induced reactions for isotopes of U, Np and Pu at energies 0-100 MeV.

31077 (LA-UR–95-17922, pp. 835-840) **Status of nuclear data for actinides.** Guzhovskii, B.Y. (Russia Federal Nuclear Centre, Arzamas (Russian Federation)); Gorelov, V.P.; Grebennikov, A.N. Los Alamos National Lab., NM (United States). [1995]. (CONF-9407103–: International conference on accelerator-driven transmutation technologies and applications, Las Vegas, NV (United States), 25 Jul - 1 aug 1994). In *AIP conference on accelerator driven transmutation technologies and applications, Los Vegas, Nevada, July 25-29, 1994.* 958p. Order Number DE95014018. Source: OSTI; NTIS; INIS.

Nuclear data required for transmutation problem include many actinide nuclei. In present paper the analysis of neutron fission, capture, (n,2n) and (n,3n) reaction cross sections at energy region from thermal point to 14 MeV was carried out for Th, Pa, U, Np, Pu, Am and Cm isotops using modern evaluated nuclear data libraries and handbooks of recommended nuclear data. Comparison of these data indicates on substantial discrepancies in different versions of files, that connect with quality and completeness of original experimental data.

31078 (LA-UR–95-17922, pp. 841-846) **Measurement of ^{238}Np fission cross-section by neutrons near thermal point (preliminary results).** Abramo (Institute of Experimental Physics, Arzamas (Russian Federation)); vich, S.N.; Andreev, M.F.; Bol'shakov, Y.M. Los Alamos National Lab., NM (United States). [1995]. (CONF-9407103–: International conference on accelerator-driven transmutation technologies and applications, Las Vegas, NV (United States), 25 Jul - 1 aug 1994). In *AIP conference on accelerator driven transmutation technologies and applications, Los Vegas, Nevada, July 25-29, 1994.* 958p. Order Number DE95014018. Source: OSTI; NTIS; INIS.

Measurements have been carried out of ^{238}Np fission cross-section by thermal neutrons. The isotope ^{238}Np was built up through the reaction ^{238}U(p,n) on an electrostatic accelerator. Extraction and cleaning of the sample were done by ion-exchange chromatography. Fast neutrons were generated on the electrostatic accelerator through the reaction ^{9}Be(d,n); a polyethylene block was used to slow down neutrons. Registration of fission fragments was performed with dielectric track detectors. Suggesting that the behavior of ^{238}Np and ^{238}U. Westscott's factors are indentical the fission cross-section of ^{238}Np was obtained: σ_{fo}=2110 $\pm$ 75 barn.

31079 (LA-UR–95-17922, pp. 847-849) **On the preequilibrium emission of clusters.** Lunev, V.P. (Institute of Physics and Power Engineering, Obninsk (Russian Federation)); Masterov, V.S.; Pronyaev, A.V. Los Alamos National Lab., NM (United States). [1995]. (CONF-9407103–: International conference on accelerator-driven transmutation technologies and applications, Las Vegas, NV (United States), 25 Jul - 1 aug 1994). In *AIP conference on accelerator driven transmutation technologies and applications, Los Vegas, Nevada, July 25-29, 1994.* 958p. Order Number DE95014018. Source: OSTI; NTIS; INIS.

An approach for the description of the preequilibrium emission of light composite particles in the framework of the exciton model is proposed. The description is analogous to the Iwamoto-Harada (I-H) model in which formation factors (FF) of clusters are obtained and the possibility of pick up process is taken into account. In the model proposed phase-space volume corresponding some arbitrary type of cluster with fixed excitation energies of nucleons picked up below and above Fermi Surface (FS) is calculated. This allows the authors to obtain the correct distribution of excitation energy between particle and hole degrees of freedom in the final state density of system: compound nucleus - cluster. The simple factorized form of the final state density of system can be obtained by introducing the average values of excitation energy of cluster constituent particles. The result of I-H treatment is valid only if one neglects the hole energy of picked up m particles, and thus it results in the overestimation of final states density and correspondingly overestimates cross-sections in comparison with the approach proposed. The numerical calculations of modified formation factors (MFF) of alpha particle and tritium are performed.

31080 (LA-UR–95-17922, pp. 876) **Long-lived isotopes production in Pb-Bi target irradiated by high energy protons.** Korovin, Y.A. (Obninsk Institute of Nuclear Power Engineering, Obninsk (Russian Federation)); Konobeyev, A.Y.; Pereslavtsev, P.E. Los Alamos National Lab., NM (United States). [1995]. (CONF-9407103–: International conference on accelerator-driven transmutation technologies and applications, Las Vegas, NV (United States), 25 Jul - 1 aug 1994). In *AIP conference on accelerator driven transmutation technologies and applications, Los Vegas, Nevada, July 25-29, 1994.* 958p. Order Number DE95014018. Source: OSTI; NTIS; INIS.

Concentration of long-lived isotopes has been calculated for lead and lead-bismuth targets irradiated by protons with energy 0.4, 0.8, 1.0 and 1.6 GeV. The time of irradiation is equal from 1 month up to 2 years. The data libraries BROND, ADL and MENDL have been used to obtain the rate of nuclide transmutation. All calculations have been performed using the SNT code.

31081 (LA-UR–95-17922, pp. 946) **Summary of experiments and data breakout group.** Wender, S. (Los Alamos National Laboratory, NM (United States)). Los Alamos National Lab., NM (United States). [1995]. (CONF-9407103–: International conference on accelerator-driven transmutation technologies and applications, Las Vegas, NV (United States), 25 Jul - 1 aug 1994). In *AIP conference on accelerator driven transmutation technologies and applications, Los Vegas, Nevada, July 25-29, 1994.* 958p. Order Number DE95014018. Source: OSTI; NTIS; INIS.

The Experiments and Data Breakout Group addressed status of experiments directed towards, or relevant to, ADTT system development. Such experiments are the bridge between ideas and reality. They simultaneously cross cut all major technology and components of ADTT systems - accelerators, target/blanket, separations, and materials. At this Conference the large majority of papers dealing with experiments were on nuclear data and cross sections. No separate papers were presented on materials experiments although data were included in papers presented at the several sessions on materials. Beginning engineering experiments were also discussed which could address issues such as neutronics performance and code benchmarking, handling of special products through processes such as sparging of volatiles, determination of thermal hydraulics performance, and beginning safety performance. One recommendation from this group was the formation of a group to collate and prioritize data needs and to provide input to existing data centers.

31082 (LBL–37120) **First results from experiment NA49 at the CERN SPS with 158 GeV/nucleon Pb on Pb collisions.** Rudolph, H. NA49 Collaboration. Lawrence Berkeley Lab., CA (United States). Mar 1995. 6p. Sponsored by USDOE, Washington, DC (United States). DOE Contract AC03-76SF00098. (CONF-9502106–3: Winter workshop on nuclear dynamics, Key West, FL (United States), 11-17 Feb 1995). Order Number DE95014830. Source: OSTI; NTIS; INIS; GPO Dep.

CERN experiment NA49 had its first beam time in November/December 1994 with a ^{208}Pb beam of 158 GeV/nucleon. The experimental setup to study Pb+Pb collisions is described and first results on two particle correlations and transverse energy production are discussed.

31083 (LBL–37121) **Progress in collective flow studies from the onset to Bevalac/SIS.** Lisa, M.A. Lawrence Berkeley

Lab., CA (United States). Mar 1995. 10p. Sponsored by USDOE, Washington, DC (United States). DOE Contract AC03-76SF00098. (CONF-9502106–2: Winter workshop on nuclear dynamics, Key West, FL (United States), 11-17 Feb 1995). Order Number DE95014831. Source: OSTI; NTIS; INIS; GPO Dep.

Collective flow in heavy ion collisions was first observed experimentally more than a decade ago at the Bevalac by the Plastic Ball collaboration. Although early calculations had suggested that measurement of the flow would place tight constraints on the nuclear equation of state, uncertainties in other input parameters of microscopic models, which also affect the flow, led to large ambiguities in the equation of state. This talk will discuss recent flow studies that attempt to overcome these difficulties. The EOS and FOPI experiments at the Bevalac and SIS accelerators have measured flow in the 200–2000 A-MeV bombarding energy range with better acceptance, particle identification, and systematics than was previously available. Meanwhile, programs at MSU and GANIL are studying the disappearance of flow around 50 A-MeV. Systematic comparison of these data with predictions of microscopic models is beginning to reduce the ambiguities in the extraction of physics quantities. Also, new directions in flow studies, such as the flow of produced particles and radial flow, offer the possibility of further information from flow studies. Recent accomplishments and new directions in flow studies are discussed, and areas where further study is needed are pointed out.

31084 (UCRL-ID–121571, pp. Paper 6, 7 Pages) **Measurements of strangeness production in the STAR experiment at RHIC.** Wilson, W.K. (Wayne State Univ., Detroit, MI (United States)). Lawrence Berkeley Lab., CA (United States). 15 Jul 1995. (CONF-950198–: Physics with the collider detectors at Relativistic Heavy Ion Collider (RHIC) and the LHC, Livermore, CA (United States), 8 Jan 1995). In *Physics with the collider detectors at RHIC and the LHC.* 212p. Order Number DE95015976. Source: OSTI; NTIS; INIS; GPO Dep.

Simulations of the ability of the STAR (Solenoidal Tracker at RHIC) detector to measure strangeness production in central Au+Au collisions at RHIC are presented. Emphasis is placed on the reconstruction of short lived particles using a high resolution inner tracker. The prospects for performing neutral kaon interferometry are discussed. Simulation results for measurements of strange and multi-strange baryons are presented.

31085 (UCRL-ID–121571, pp. Paper 9, 20 Pages) **Analysis of single events in ultrarelativistic nuclear collisions: A new method to search for critical fluctuations.** Stock, R. (Univ. of Frankfurt (Germany)). Lawrence Berkeley Lab., CA (United States). 15 Jul 1995. (CONF-950198–: Physics with the collider detectors at Relativistic Heavy Ion Collider (RHIC) and the LHC, Livermore, CA (United States), 8 Jan 1995). In *Physics with the collider detectors at RHIC and the LHC.* 212p. Order Number DE95015976. Source: OSTI; NTIS; INIS; GPO Dep.

The upcoming generation of experiments with ultrarelativistic heavy nuclear projectiles, at the CERN SPS and at RHIC and LHC, will confront researchers with several thousand identified hadrons per event, suitable detectors provided. An analysis of individual events becomes meaningful concerning a multitude of hadronic signals thought to reveal a transient deconfinement phase transition, or the related critical precursor fluctuations. Transverse momentum spectra, the kaon to pion ratio, and pionic Bose-Einstein correlation are examined, showing how to separate the extreme, probably rare candidate events from the bulk of average events. This type of observables can already be investigated with the Pb beam of the SPS. The author then discusses single event signals that add to the above at RHIC and LHC energies, kaon interferometry, rapidity fluctuation, jet and γ production.

31086 (UCRL-ID–121571, pp. Paper 10, 8 Pages) **Concepts of event-by-event analysis.** Stroebele, H. (Universitaet Frankfurt (Germany)). Lawrence Berkeley Lab., CA (United States). 15 Jul 1995. (CONF-950198–: Physics with the collider detectors at Relativistic Heavy Ion Collider (RHIC) and the LHC, Livermore, CA (United States), 8 Jan 1995). In *Physics with the collider detectors at RHIC and the LHC.* 212p. Order Number DE95015976. Source: OSTI; NTIS; INIS; GPO Dep.

The particles observed in the final state of nuclear collisions can be divided into two classes: those which are susceptible to strong interactions and those which are not, like leptons and the photon. The bulk properties of the "matter" in the reaction zone may be read-off the kinematical characteristics of the particles observable in the final state. These characteristics are strongly dependent on the last interaction these particles have undergone. In a densly populated reaction zone strongly interacting particles will experience many collisions after they have been formed and before they emerge into the asymptotic final state. For the particles which are not sensitive to strong interactions their formation is also their last interaction. Thus photons and leptons probe the period during which they are produced whereas hadrons reflect the so called freeze-out processes, which occur during the late stage in the evolution of the reaction when the population density becomes small and the mean free paths long. The disadvantage of the leptons and photons is their small production cross section; they cannot be used in an analysis of the characteristics of individual collision events, because the number of particles produced per event is too small. The hadrons, on the other hand, stem from the freeze-out period. Information from earlier periods requires multiparticle observables in the most general sense. It is one of the challenges of present day high energy nuclear physics to establish and understand global observables which differentiate between mere hadronic scenarios, i.e superposition of hadronic interactions, and the formation of a partonic (short duration) steady state which can be considered a new state of matter, the Quark-Gluon Plasma.

31087 (UCRL-ID–121571, pp. Paper 11, 10 Pages) **Measuring two-particle Bose-Einstein correlations with PHOBOS@RHIC.** Betts, R. (and others); Barton, D.; Carroll, A. Lawrence Berkeley Lab., CA (United States). 15 Jul 1995. (CONF-950198–: Physics with the collider detectors at Relativistic Heavy Ion Collider (RHIC) and the LHC, Livermore, CA (United States), 8 Jan 1995). In *Physics with the collider detectors at RHIC and the LHC.* 212p. Order Number DE95015976. Source: OSTI; NTIS; INIS; GPO Dep.

The authors present results of a simulation of the measurement of two-particle Bose-Einstein correlations in central Au-Au collisions with the PHOBOS detector at RHIC. This measurement is expected to yield information on the relevant time and distance scales in these collisions. As the space-time scale is directly connected with the equation of state governing the evolution of the particle source, this information will be essential in understanding the physics of nucleus-nucleus collisions at RHIC energies. The authors demonstrate that the PHOBOS detector has sufficient resolution and acceptance to distinguish a variety of physics scenarios.

31088 (UCRL-ID–121571, pp. Paper 12, 10 Pages) **HBT measurements in PHENIX, STAR and ALICE.** Zajac, W.A. (Columbia Univ., Irvington, NY (United States)). Lawrence Berkeley Lab., CA (United States). 15 Jul 1995. DOE Contract FG02-86ER40281. (CONF-950198–: Physics with the collider detectors at Relativistic Heavy Ion Collider (RHIC) and the LHC, Livermore, CA (United States), 8 Jan 1995). In *Physics with the collider detectors at RHIC and the LHC.* 212p. Order Number DE95015976. Source: OSTI; NTIS; INIS; GPO Dep.

The experimental prospects for performing Hanbury-Brown-Twiss (HBT) measurements in the large detectors planned for heavy ion physics at RHIC and LHC are reviewed.

31089 (UCRL-ID–121571, pp. Paper 16, 8 Pages) **Studies for dimuon measurement with ALICE.** Jouan, D. (Institut de Physique, Orsay (France)). Lawrence Berkeley Lab., CA (United States). 15 Jul 1995. (CONF-950198–: Physics with the collider detectors at Relativistic Heavy Ion Collider (RHIC) and the LHC, Livermore, CA (United States), 8 Jan 1995). In *Physics with the collider detectors at RHIC and the LHC.* 212p. Order Number DE95015976. Source: OSTI; NTIS; INIS; GPO Dep.

The idea of measuring dimuon in the ALICE detector is not new, since it already appeared in the Aachen Conference. In the meantime studies were aiming at the use of the two detectors of LHC p-p physics, CMS and ATLAS, already dedicated to dimuon measurement, for these same measurements in heavy ion collisions, whereas the detector dedicated to heavy ions physics at LHC, ALICE, was considering all the other observables. Recently, the

interest for dimuon measurements in ALICE was renewed by demands from LHC committee, stiring the activities of a working group in the ALICE collaboration, also associated to a more recent move from new groups. In the following the author briefly describes the interest of measuring dimuons in heavy ion collisions, particularly in ALICE, then the experimental strategy and first estimates of the performances that could be reached with the proposed system.

31090 (UCRL-ID–121571, pp. Paper 20, 6 pages) **Is there a role for fixed target heavy ion physics beyond RHIC startup.** Sandweiss, J. (Yale Univ., New Haven, CT (United States)). Lawrence Berkeley Lab., CA (United States). 15 Jul 1995. (CONF-950198–: Physics with the collider detectors at Relavitistic Heavy Ion Collider (RHIC) and the LHC, Livermore, CA (United States), 8 Jan 1995). In *Physics with the collider detectors at RHIC and the LHC*. 212p. Order Number DE95015976. Source: OSTI; NTIS; INIS; GPO Dep.

The interesting and important physics opportunities provided by AGS and CERN fixed target facilities will be far from exhausted by the time of RHIC turn on. Given the need for the AGS to provide heavy ion beams for injection into RHIC, the cost effectiveness of fixed target experimentation with AGS beams will be high. Examples of the physics are given.

31091 (UM-P–94/03) **Excitation function for the population of the 4.51 MeV state of ^{27}Al inelastic proton scattering. Evidence for 6$^-$ strength.** Spicer, B.M. (Melbourne Univ., Parkville, VIC (Australia). School of Physics); Koutsoliotas, S.; Dytlewski, N.; Cohen, D.D.; Geso, Moshi. Melbourne Univ., Parkville, VIC (Australia). School of Physics. [1995]. 9p. Sponsored by Australian Inst. of Nuclear Science and Engineering, Lucas Heights, NSW (Australia). Order Number DE96602867. Source: OSTI; NTIS; INIS.

The excitation function for emission of 2.30 MeV gamma rays from the 4.51 MeV state of ^{27}Al formed in inelastic proton scattering has been measured for proton energies from 5.6 to 7.3 MeV. A resonance previously seen in both inelastic electron and proton scattering from ^{28}Si at 17.35 MeV has been observed as a resonance in the excitation function, as well as seven other resonances, all of which are narrow (i.e., less than 100 keV wide). It is suggested that these may represent fragments of 6$^-$ strength in ^{28}Si. 6 refs., 1 tab., 2 figs.

31092 (UM-P–94/61) **Research report to the Gordon conference on photonuclear reactions.** Melbourne Univ., Parkville, VIC (Australia). School of Physics. 1994. 16p. (CONF-940867–: Gordon research conference on photonuclear reactions, Tilton, NH (United States), 1-5 Aug 1994). Order Number DE96602854. Source: OSTI; NTIS; INIS.

Since the last report, the photonuclear experimental program has been pursued using the facilities at the Laboratory of Nuclear Science of Tohoku University, at the MAX Lab. at Lund University and at Saskatchewan University. This report summarises the current progress in studies at energies up to 100 MeV, and lists recently published papers. Six of the papers were indexed separately. refs., figs.

31093 (UM-P–95/04) **Parametrizations of thermonuclear reaction rates for reactions leading to N=28 nuclei.** Morton, A.J.; Sargood, D.G. Melbourne Univ., Parkville, VIC (Australia). School of Physics. 1995. 15p. Order Number DE96602869. Source: OSTI; NTIS; INIS.

Previously published results of statistical-model calculations of the rates of proton, neutron and α-particle induced reactions on 36 intermediate mass targets at temperatures representative of those found in pre-supernova massive stars have been parametrized for use in stellar modelling calculations. The parametrization equations and the parameters are presented, together with the temperature ranges ($1.8 < T_9 < 5.5$) over which the parametrizations are believed to be reliable. 4 refs., 9 tabs.

6635 Nuclear Mass Ranges

Refer also to citation(s) 30284, 31019, 31020, 31041, 31043, 31060, 31068, 31069, 31071, 31072, 31073, 31074, 31075, 31076, 31077, 31078, 31080, 31084, 31091, 31093

6636 Radiation Physics

Refer also to citation(s) 29181, 29498, 29499, 29529, 30415, 30506, 31134, 31382

31094 (IAEA-NDS–197) **ENDF/B-6 TSL2. The ENDF/B-6 thermal neutron scattering sublibrary, release 2. Summary documentation.** IAEA-NDS–Documentation Series, IAEA-NDS–Documentation Series. Lemmel, H.D. International Atomic Energy Agency, Vienna (Austria). Nuclear Data Section. Jun 1995. 3p. Order Number DE96602880. Source: OSTI; NTIS (US Sales Only); INIS.

This neutron nuclear data library contains thermal neutron scattering law data for twelve neutron moderator materials. The data are given in ENDF-6 format. The data library is available from the IAEA Nuclear Data Section on magnetic tape, costfree upon request. (author).

31095 (INDC(CPR)–035) **Analyses of neutron multiplication integral experiments on beryllium.** Liu Lianyan (Institute of Applied Physics and Computational Mathematics, Beijing (China)); Zhang Yuquan. International Atomic Energy Agency, Vienna (Austria). International Nuclear Data Committee. Dec 1994. 32p. Order Number DE96602280. Source: OSTI; NTIS (US Sales Only); INIS.

The work is devoted to analyses of neutron multiplication integral experiments on beryllium, carried out at Southwest Institute of Nuclear and Chemistry (SWINPC), Chengdu, China. Four parts are included. Part II gives a brief description of the SWINPC beryllium experiments. In Part III, Monte Carlo transport code MCNP is used to simulate the experiments in every detail, so as to analyze the questions concerning the experimental method and procedure, including validity of measurement by an ideal U-235 fission chamber detector, influence of the impurities in beryllium samples and D-T source structure materials, anisotropic effect of the experiment system, calculational factors and their errors. Part IV puts emphases on perturbation of the detecting system to measured values, caused by the in-system detecting procedure. ANISN-MORSE coupled method is developed to deal with the problem. Calculational results give a disappointing conclusion on the detecting system. Up to 6% integral deviations occur to measured results, becoming experimental system errors. Corrections need to be made. In Part V, the beryllium experiments are simplified to a one-dimensional benchmark problem. The final experimental neutron leakage multiplications are compared with the benchmark calculations by using ENDF/B-IV, ENDF/B-VI, JENDL-3 and LASL-Sub beryllium data. Large differences are found between the neutron leakage multiplications by experiment and calculation, far beyond the experimental errors reported by experimenters, suggesting the inefficiency of the current beryllium evaluated data. Further studies on beryllium nuclear data are recommended. (author). 11 refs, 9 figs, 9 tabs.

31096 (INDC(NDS)–313) **FENDL neutronics benchmark: Neutron leakage spectra from Be, Fe, Pb, PbLi shells with 14MeV neutron source.** Simakov, S.P. (Institute of Physics and Power Engineering, Obninsk (Russian Federation)); Devkin, B.V.; Kobozev, M.G.; Talalaev, V.A. International Atomic Energy Agency, Vienna (Austria). International Nuclear Data Committee. Dec 1994. 19p. Order Number DE96602281. Source: OSTI; NTIS (US Sales Only); INIS.

Following the recommendations of an IAEA Consultant's Meeting on "Preparation of Fusion Benchmarks in Electronic Format for Nuclear Data Validation Studies", the present report on benchmark experiments with 14-MeV neutrons on beryllium, iron, lead and lead-lithium alloy was prepared. It complements the experimental data available on-line from the IAEA Nuclear Data Section so as to enable any user to perform transport calculations for this experiment in order to validate nuclear data libraries, such as the Fusion Evaluated Nuclear Data Library (FENDL). (author). 7 refs, 10 figs, 2 tabs.

31097 (INDC(NDS)–314) **FENDL neutronics benchmark: Neutron multiplication measurements in beryllium, beryllium oxide and lead with 14-MeV neutrons.** Basu, T.K. (Bhabha Atomic Research Centre, Bombay (India). Neutron Physics Div.). International Atomic Energy Agency, Vienna (Austria). International

Nuclear Data Committee. Dec 1994. 7p. Order Number DE96602282. Source: OSTI; NTIS (US Sales Only); INIS.

Following the recommendations of an IAEA Consultant's Meeting on "Preparation of Fusion Benchmarks in Electronic Format for Nuclear Data Validation Studies", the present report on benchmark experiments with 14-MeV neutrons on beryllium, beryllium oxide and lead was prepared. It complements the experimental data available on-line from the IAEA Nuclear Data Section so as to enable any user to perform transport calculations for this experiment in order to validate nuclear data libraries, such as the Fusion Evaluated Nuclear Data Library (FENDL). (author). 6 refs, 1 tab.

31098 (INDC(NDS)–315) **FENDL neutronics benchmark: Stainless steel bulk shield experiment performed at Frascati neutron generator.** Martone, M. (ENEA, Ente per le Nuove Tecnologie, l'Energia e l'Ambiente, Frascati (Italy). Neutronics Div., Fusion Dept.); Angelone, M.; Batistoni, P.; Pillon, M.; Rado, V. International Atomic Energy Agency, Vienna (Austria). International Nuclear Data Committee. Dec 1994. 37p. Order Number DE96602283. Source: OSTI; NTIS (US Sales Only); INIS.

Following the recommendations of an IAEA Consultant's Meeting on "Preparation of Fusion Benchmarks in Electronic Format for Nuclear Data Validation Studies", the present report on benchmark experiments with 14-MeV neutrons on stainless steel block was prepared. It complements the experimental data available on-line from the IAEA Nuclear Data Section so as to enable any user to perform transport calculations for this experiment in order to validate nuclear data libraries, such as the Fusion Evaluated Nuclear Data Library (FENDL). (author). 2 refs, figs and tabs.

31099 (LA–12906-PR) **The Manuel Lujan Jr. Neutron Scattering Center (LANSCE) experiment reports 1993 run cycle. Progress report.** Farrer, R.; Longshore, A. (comps.). Los Alamos National Lab., NM (United States). Jun 1995. 214p. Sponsored by USDOE, Washington, DC (United States). DOE Contract W-7405-ENG-36. Order Number DE95016181. Source: OSTI; NTIS; INIS; GPO Dep.

This year the Manuel Lujan Jr. Neutron Scattering Center (LANSCE) ran an informal user program because the US Department of Energy planned to close LANSCE in FY1994. As a result, an advisory committee recommended that LANSCE scientists and their collaborators complete work in progress. At LANSCE, neutrons are produced by spallation when a pulsed, 800-MeV proton beam impinges on a tungsten target. The proton pulses are provided by the Clinton P. Anderson Meson Physics Facility (LAMPF) accelerator and a associated Proton Storage Ring (PSR), which can iter the intensity, time structure, and repetition rate of the pulses. The LAMPF protons of Line D are shared between the LANSCE target and the Weapons Neutron Research (WNR) facility, which results in LANSCE spectrometers being available to external users for unclassified research about 80% of each annual LAMPF run cycle. Measurements of interest to the Los Alamos National Laboratory (LANL) may also be performed and may occupy up to an additional 20% of the available beam time. These experiments are reviewed by an internal program advisory committee. This year, a total of 127 proposals were submitted. The proposed experiments involved 229 scientists, 57 of whom visited LANSCE to participate in measurements. In addition, 3 (nuclear physics) participating research teams, comprising 44 scientists, carried out experiments at LANSCE. Instrument beam time was again oversubscribed, with 552 total days requested an 473 available for allocation.

31100 (UCRL–78378) **Flux limiting nature's own way – A new method for numerical solution of the transport equation.** Kershaw, D.S. Lawrence Livermore National Lab., CA (United States). 29 Jul 1976. 25p. Sponsored by USDOE, Washington, DC (United States). DOE Contract W-7405-ENG-48. Order Number DE95017708. Source: OSTI; NTIS; GPO Dep.

The transport equation may be solved by expanding it in spherical harmonics, Y_{lm}, and truncating the resultant infinite set of equations at some finite order L. This procedure leaves the (L + 1)th order moments which appear in the Lth order equation undetermined, and the standard procedure for obtaining a closed set of equations has been to set all the (L + 1)th order moments to zero. It has been shown here that this procedure actually violates the apriori knowledge that one is solving for the moments of a probability measure on the unit sphere. Using the theory of moments of a probability measure on the unit sphere. Using the theory of moments as discussed above, the (L + 1)th order moments can be chosen in accordance with apriori knowledge. The resultant truncated set of equations has properties much truer to the original transport equation than the usual set obtained by setting the (L + 1)th order moments to zero. In particular the truncated set of equations gets the solution of the transport equation exactly right in both the diffusion limit and the free streaming limit. Furthermore, this has been achieved by merely truncating the set of equations properly and not by any ad hoc changes in the basic equations as is the case in the approaches that use flux limiters.

6640 Atomic and Molecular Physics

Refer also to citation(s) 30283, 31037

31101 (DOE/ER–13491-798) **Atomic physics with highly charged ions. Progress report for FY 1995.** Richard, P. Kansas State Univ., Manhattan, KS (United States). J.R. MacDonald Lab. Sep 1995. 15p. Sponsored by USDOE, Washington, DC (United States). DOE Contract FG02-86ER13491. Order Number DE96001127. Source: OSTI; NTIS; GPO Dep.

This report describes progress made during the previous year in experimental and theoretical investigations of high- and low-energy collisions involving multiply charged ions. The work from previous years has resulted in publication of 27 papers in refereed journals during the last twelve months. This report includes a list of published manuscripts as well as lists of abstracts for five different conferences/workshops during the grant period.

6641 Theory of Electronic Structure of Atoms and Molecules

Refer also to citation(s) 31127

31102 (LBL–37588) **Excited state carrier dynamics in CdS_xSe_{1-x} semiconductor alloys as studied by ultrafast fluorescence spectroscopy.** Gadd, S.E. Lawrence Berkeley Lab., CA (United States). Aug 1995. 272p. Sponsored by USDOE, Washington, DC (United States);National Science Foundation, Washington, DC (United States);Department of Defense, Washington, DC (United States). DOE Contract AC03-76SF00098. Order Number DE96000115. Source: OSTI; NTIS; GPO Dep.

This dissertation discusses studies of the electron-hole pair dynamics of CdS_xSe_{1-x} semiconductor alloys for the entire compositional range from x = 1 to x = 0 as examined by the ultrafast fluorescence techniques of time correlated single photon counting and fluorescence upconversion. Specifically, samples with x = 1, .75, .5, .25, and 0 were studied each at a spread of wavelengths about its respective emission maximum which varies according to λ = 718nm - 210x nm. The decays of these samples were found to obey a Kohlrausch distribution, $\exp[(t/\tau)^{\beta}]$, with the exponent 3 in the range .5-.7 for the alloys. These results are in agreement with those expected for localization due to local potential variations resulting from the random distribution of sulfur and selenium atoms on the element VI A sub-lattice. This localization can be understood in terms of Anderson localization of the holes in states whose energy distribution tails into the forbidden energy band-gap. Because these states have energy dependent lifetimes, the carriers can decay via many parallel channels. This distribution of channels is the ultimate source of the Kohlrausch form of the fluorescence decays.

31103 (SAND–95-1976C) **Small bipolarons in boron carbides: Pair breaking in semiclassical hopping.** Emin, D. Sandia National Labs., Albuquerque, NM (United States). [1995]. 10p. Sponsored by USDOE, Washington, DC (United States). DOE Contract AC04-94AL85000. (CONF-9508166–2: 6. international conference on hopping and related phenomena, Jerusalem (Israel), 27-30 Aug 1995). Order Number DE95017893. Source: OSTI; NTIS; GPO Dep.

A pair of charge carriers can be bound within a common potential well produced by displacing atoms from their carrier-free equilibrium positions. These two self-trapped carriers together with

the associated atomic-displacement pattern is referred to as a bipolaron. If the self-trapped carriers' wavefunction is primarily confined to a single structural unit (atom, bond or molecule), the bipolaron is termed small. If however the self-trapped carriers' wavefunction extends over multiple structural units, the bipolaron is called large. Small bipolarons form in crystals if the energy lowering due to the carriers' self-trapping exceeds the electronic-transfer energy associated with an electronic carrier's intersite motion. Small-polaron and -bipolaron formation is also often induced by disorder. Interest in bipolarons focuses on situations in which they are energetically stable with respect to dissociating into two individual carriers. Stability is achieved when the additional lowering of the atomic-displacement-related energy arising from two carriers sharing a common site overwhelms their mutual Coulomb repulsion. Self-trapped carriers only move when the positions of the atoms whose displacements produce self-trapping change. When atoms move so as to shift small-polaronic self-trapped carriers between adjacent sites, changes of the self-trapped carriers' energies always exceed their intersite electronic transfer energy. Since small-polaronic self-trapped carriers thereby lose coherence as they move, their transport is described as hopping incoherently between localized states. This report discusses the electronic structure of boron carbides and describes features that make them ideal for studying small bipolaron hopping. The effect on conductivity is discussed.

31104 (UCRL-ID–120378) **Fully relativistic surface green function and its application to surface spectroscopies.** Tamura, E. (Seaborg (Glenn T.) Inst. for Transactinium Science, Livermore, CA (United States)). Lawrence Livermore National Lab., CA (United States). 30 Jun 1993. 11p. Sponsored by USDOE, Washington, DC (United States). DOE Contract W-7405-ENG-48. Order Number DE95017029. Source: OSTI; NTIS; INIS; GPO Dep.

A fully relativistic layer-KKR formalism was developed and implemented for calculating the single-particle Green function in atomic layers parallel to crystalline surfaces magnetic and non magnetic materials: The method was applied to the calculation surface spectroscopies, such as low energy electron diffraction (LEED), angle-resolve ultraviolet photo emission spectroscopy (UPS), and photoelectron scattering. Numeric tests were performed for non magnetic actinide surfaces and magnetic Fe surface Theoretical angle-resolved UPS spectra are presented for uranium monolayers on Pt(111) and for f.c.c. u(lll) surfaces. We find that u island formation can take place if a peak in the UPS spectra appears just before the Fermi energy immediately as u is deposited on P and we suggest an experimental procedure for testing this prediction. An intensity map photo excited electrons from the $2p_{3/2}$ core states of Fe(110) surface is also show Sizable magnetic anisotropy is found due to the interference between exchange and spin-orbit interaction, which is suitable for studying a possible surface-induced magnetism actinide adlayers.

6642 Spectra of Atoms and Molecules and Their Interactions With Photons

Refer also to citation(s) 30388, 30874, 31056, 31057, 31114

31105 (LA-UR–95-2694) **Multiphoton physics with x-rays.** Kyrala, G. Los Alamos National Lab., NM (United States). [1995]. 12p. Sponsored by USDOE, Washington, DC (United States). DOE Contract W-7405-ENG-36. (CONF-9508154–1: NATO workshop on super intense laser physics, Moscow (Russian Federation), 4-9 Aug 1995). Order Number DE95016944. Source: OSTI; NTIS; INIS; GPO Dep.

With the generation of intense bursts of short wavelength radiation during the interaction of ultra-intense laser beams with solid targets, the possibility of extending the study of the non-linear interactions of radiation with matter to shorter and shorter wavelength radiation becomes possible. One would hope that an extension of the techniques to the x-ray region would lead to new tools that are similar to those used in the visible and that can be widely applied. However, a basic knowledge of the relevant efficiencies of the properties of the materials, under these unusual conditions, is necessary before one can build such sources and devices. In this work the authors discuss the design of the first experiments on non-linear interactions using x-rays in the kilovolt energy range, and present some of the some of the early findings. They concentrate on the possibility of measuring the simplest non-linear process, two-photon inner-shell ionization of chlorine.

6643 Collision Phenomena

Refer also to citation(s) 30874

31106 (IC–95/100) **Collisional excitation among the seven lowest states of TiXII.** Mohan, M. (International Centre for Theoretical Physics, Trieste (Italy)); Hibbert, A. International Centre for Theoretical Physics, Trieste (Italy). Jun 1995. 12p. Order Number DE96602305. Source: OSTI; NTIS (US Sales Only); INIS.

Collision strengths have been calculated for electron impact excitation of sodium-like TiXII for all transitions within its seven lowest states. Configuration interaction wave-functions have been used to represent the target states. The standard and no-exchange R-matrix codes have been used to calculate the contribution of partial waves with $L \leq 9$ and $L > 9$ respectively. Collision strengths are tabulated at selected energies in the range 26 to 50 Ryd. for all 21 transitions within seven lowest states. Effective collision strengths are tabulated for electron temperatures in the range logTe = 4.00 to logTe = 6.00 with Te expressed in deg. C K. This is the first detailed calculation on this ion in which the effects of exchange, channel couplings and short-range correlation effects are taken into account. (author). 25 refs, 1 fig., 5 tabs.

31107 (LA-UR–95-2878) **The linear algebraic method for electron-molecule collisions.** Collins, L.A. (Los Alamos National Lab., NM (United States)); Schneider, B.I. Los Alamos National Lab., NM (United States). [1995]. 15p. Sponsored by USDOE, Washington, DC (United States). DOE Contract W-7405-ENG-36. (CONF-9503177–1: comparative study of current methodologies in electron-molecule scattering, Cambridge, MA (United States), 11-13 Mar 1995). Order Number DE95016931. Source: OSTI; NTIS; GPO Dep.

In order to find numerical solutions to many problems in physics, chemistry and engineering it is necessary to place the equations of motion (classical or quantal) of the variables of dynamical interest on a discrete mesh. The formulation of scattering theory in quantum mechanics is no exception and leads to partial differential or integral equations which may only be solved on digital computers. Typical approaches introduce a numerical grid or basis set expansion of the scattering wavefunction in order to reduce 'the problem to the solution of a set of algebraic equations. Often it is more convenient to deal with the scattering matrix or phase amplitude rather than the wavefunction but the essential features of the numerics are unchanged. In this section we will formulate the Linear Algebraic Method (LAM) for electron-atom/molecule scattering for a simple, one-dimensional radial potential. This will illustrate the basic approach and enable the uninitiated reader to follow the subsequent discussion of the general, multi-channel, electron-molecule formulation without undue difficulty. We begin by writing the Schroedinger equation for the s-wave scattering of a structureless particle by a short-range, local potential.

31108 (LBL–37272) **Crossed molecular beams study of $O(^1D)$ reactions with H_2 molecules.** Miau, T.T. Lawrence Berkeley Lab., CA (United States). May 1995. 65p. Sponsored by USDOE, Washington, DC (United States). DOE Contract AC03-76SF00098. Order Number DE95014796. Source: OSTI; NTIS; GPO Dep.

Reaction dynamics of $O(^1D)$ atoms with H_2 molecules was reinvestigated using the crossed molecular beams technique with pulsed beams. The $O(^1D)$ beam was generated by photodissociating O_3 molecules at 248 nm. Time-of-flight spectra and the laboratory angular distribution of the OH products were measured. The derived OH product center-of-mass flux-velocity contour diagram shows more backward scattered intensity with respect to the $O(^1D)$ beam. In contrast to previous studies which show that the insertion mechanism is the dominant process, our results indicate that the contribution from the collinear approach of the $O(^1D)$ atom to the H_2 molecule on the first excited state potential energy surface is significant and the energy barrier for the collinear approach is therefore minimal. Despite the increased time resolution in this

experiment, no vibrational structure in the OH product time-of-flight spectra was resolved. This is in agreement with LIF studies, which have shown that the rotational distributions of the OH products in all vibrational states are broad and highly inverted.

31109 (LBL–37545) **On the quantum mechanical theory of collisional recombination rates, II. Beyond the strong collision approximation.** Miller, W.H. Lawrence Berkeley Lab., CA (United States). Jul 1995. 25p. Sponsored by USDOE, Washington, DC (United States);National Science Foundation, Washington, DC (United States). DOE Contract AC03-76SF00098. Grant CHE-9422559. (CONF-951229–1: RSC general discussion meeting 102: unimolecular reaction dynamics, Oxford (United Kingdom), 19-21 Dec 1995). Order Number DE96001116. Source: OSTI; NTIS; INIS; GPO Dep.

A quantum mechanical theory of collisional recombination (within the Lindemann mechanism, $A + B \leftrightarrow AB^*$, $AB^* + M \rightarrow AB + M$) is presented which provides a proper quantum description of the A + B collision dynamics and treats the M + AB^* inelastic scattering within the impact approximation (the quantum analog of a classical master equation treatment). The most rigorous version of the theory is similar in structure to the impact theory of spectral line broadening and involves generalized (4-index) rate constants for describing M + AB^* collisions. A simplified version is also presented which involves only the normal (2-index) inelastic rate constants for M + AB^* scattering but which also retains a proper quantum description of the A + B dynamics.

31110 (UM-P–94/37) **Inversion of He-Ne elastic scattering data.** Lun, D.R.; Chen, Xuejun; Allen, L.J.; Amos, K. Melbourne Univ., Parkville, VIC (Australia). School of Physics. [1995]. 21p. Order Number DE96602887. Source: OSTI; NTIS; INIS.

Quantal and semi-classical (WKB) methods of inversion have been used in an analysis of the elastic scattering cross sections for 62.5 MeV helium atoms from neon atoms by which an effective local interaction between those atoms is specified. The potentials obtained by the approximate method (WKB) differ from that found with the full quantal analysis. The quantal inversion potential is repulsive at short distances and becomes attractive at a radius of 2.695 Angstroms. It has a minimum value of -1.981 MeV at a radius of 2.98 Angstroms. 15 refs., 3 tabs., 3 figs.

31111 (UM-P–94/124) **Inversion of total cross-section data for electron-molecule and electron-atom scattering.** Lun, D.R.; Amos, K.; Allen, L.J. Melbourne Univ., Parkville, VIC (Australia). School of Physics. [1995]. 18p. Order Number DE96602886. Source: OSTI; NTIS; INIS.

Inverse scattering theory has been applied to construct the interaction potentials from total cross sections as a function of energy. The underlying potentials are assumed to be real and are evaluated using the WKB approximation with phase shifts determined from the total cross-section data from e^- -CH_4, e^- -SiH_4, e^- -Kr and e^- -Xe scattering. The inversion potentials are different to ones by direct calculations but when they are used to recalculate the cross sections, the fit to the data is as good as those found by using the theoretical interactions. 15 refs., 1 tab., 4 figs.

6644 Experimentally Derived Information On Atomic and Molecular Properties

Refer also to citation(s) 30873, 30874, 31110

31112 (DOE/ER/13500–T4) **The photodissociation and reaction dynamics of vibrationally excited molecules. Technical progress report.** Wisconsin Univ., Madison, WI (United States). [1995]. 26p. Sponsored by USDOE, Washington, DC (United States). DOE Contract FG02-86ER13500. Order Number DE95017563. Source: OSTI; NTIS; GPO Dep.

The goal of this Department of Energy sponsored research is to discover the properties, behavior, and dissociation dynamics of vibrationally energized molecules, which are crucial participants in many chemical reactions. The authors study vibrationally energized molecules by using an optical excitation scheme to prepare them and a subsequent photon to dissociate them into fragments that they detect with a spectroscopic probe. This technique, vibrationally mediated photodissociation, provides new information on vibrationally energized molecules and even provides a means of controlling the course of a molecular decomposition. During the most recent period of Department of Energy support, the authors have advanced this work in three directions: they have used vibrational overtone excitation to control the decomposition pathways in the tetra-atomic molecule isocyanic acid (HNCO) and unravelled the decomposition pathways in hydroxylamine (NH_2OH), they have implemented stimulated Raman excitation as the vibrational state preparation technique in vibrationally mediated photodissociation, and they have tested the limits of transient grating spectroscopy as a means of obtaining electronic spectra of vibrationally excited molecules.

6650 Physics of Condensed Matter

Refer also to citation(s) 30154, 30363, 30565, 30566

31113 (ANL/CHM/PC–87054) **Why in situ, real-time characterization of thin film growth processes?** Auciello, O. (Argonne National Lab., IL (United States)); Krauss, A.R. Argonne National Lab., IL (United States). [1995]. 5p. Sponsored by USDOE, Washington, DC (United States). DOE Contract W-31-109-ENG-38. Order Number DE95015861. Source: OSTI; NTIS; INIS; GPO Dep.

Since thin-film growth occurs at the surface, the analytical methods should be highly surface-specific. although subsurface diffusion and chemical processes also affect film properties. Sampling depth and ambient-gas is compatibility are key factors which must be considered when choosing in situ probes of thin-film growth phenomena. In most cases, the sampling depth depends on the mean range of the exit species (ion, photon, or electron) in the sample. The techniques that are discussed in this issue of the MRS Bulletin (1) have been chosen because they may be used for in situ, real-time analysis of film-growth phenomena in vacuum and in the presence of ambient gases resulting either from the deposition process or as a requirement for the production of the desired chemical phase. A second criterion for inclusion is that the instrumentation be sufficiently compact and inexpensive to permit use as a dedicated tool in a thin-film deposition system.

31114 (BNL–62195) **Electron transfer and physical and chemical processes at low temperatures.** Strongin, M.; Xia, B.; Jacobsen, F.M. Brookhaven National Lab., Upton, NY (United States). [1995]. 9p. Sponsored by USDOE, Washington, DC (United States). DOE Contract AC02-76CH00016. (CONF-9508166–1: 6. international conference on hopping and related phenomena, Jerusalem (Israel), 27-30 Aug 1995). Order Number DE96000425. Source: OSTI; NTIS; GPO Dep.

We summarize some phenomena that occur at temperatures of the order of 15K, and are dominated by quantum mechanical tunneling. Although electron tunneling dominates many conduction processes at low temperatures, we discuss evidence that phenomena like oxidation, as well as the solution of alkali metals in ammonia, can also be dominated by electron tunneling. Both phenomena demonstrate that the chemical potential of a metastable system can equilibrate at low temperatures by electron tunneling. The case of alkali metal clusters covered with ammonia is contrasted to covering the clusters with Xe. In this case changes in the activated conduction are observed which are consistent with the dielectric constant of the rare gas.

31115 (BNL–62213) **Elementary excitations and phase transitions in crystals.** Shapiro, S.M. Brookhaven National Lab., Upton, NY (United States). [1993]. 15p. Sponsored by USDOE, Washington, DC (United States). DOE Contract AC02-76CH00016. (CONF-9509235–1: 7. international school on neutron physics, Dubna (Russian Federation), 3-22 Sep 1995). Order Number DE96000413. Source: OSTI; NTIS; GPO Dep.

The unique method of measuring elementary excitations in solids over a wide range of energy and momentum transfers is inelastic scattering of neutrons. Elementary excitations are defined as a correlated motion of atoms or spins in a solid which include phonons, magnons, rotons, or crystal field excitations. These excitations play a fundamental role in a wide variety of structural and magnetic phase transitions and provide the information in understanding the underlying microscopic mechanism of the transformation. Below, I

shall review some of the relevant aspects of neutron scattering formalism related to inelastic neutron scattering and demonstrate how it has been applied to the study of phase transitions in crystals. I shall give two examples of structural phase transitions where the phonons are the elementary excitations and studies in a conventional superconductor where the phonon linewidths are a measure of the electron-phonon coupling responsible for the pairing.

31116 (DOE/ER/45522–2) **The potential energy of a pair of polystyrene spheres in alternating electric fields.** Lin, S. (Brandeis Univ., Waltham, MA (United States)); Fraden, S.; Hu, Y. Brandeis Univ., Waltham, MA (United States). Dept. of Physics. Apr 1995. 10p. Sponsored by USDOE, Washington, DC (United States);Henry Luce Foundation, New York, NY (United States). DOE Contract FG02-94ER45522. (CONF-940813–43: 208. American Chemical Society national meeting, Washington, DC (United States), 21-26 Aug 1994). Order Number DE96000735. Source: OSTI; NTIS; GPO Dep.

The drastic change in the viscosity of electrorheological (ER) fluids when an external electric field is applied has intrigued scientists from many different fields including engineering, chemistry, and physics for over half a century. It has been generally understood that the microscopic attractive forces between induced dipole moments of the suspended particles have important effects on macroscopic fluid properties. Great effort has been given recently to maximizing the strength of the attractive forces between the particles in ER fluids to achieve practical fluids, and important progress has been made. In the preliminary work presented here, we focus on trying to understand the strength of the microscopic interactions between colloidal particles in alternating electric fields. The system used is a model system of aqueous suspensions of monodisperse polystyrene spheres. By using digital microscopy techniques to measure the inter-particle separations between two spheres at thousands of different times and at several different field strengths, we have been able to determine the probability density function P(r) for the separation distance r between the two particle centers. We begin this paper with a theoretical discussion in which the contributions of electrostatic repulsion, electric-field-induced dipole interaction, and van der Waals attraction to the pair potential are first considered. A probability density function for the distance between a pair of particles is then obtained from the pair potential using equilibrium statistical mechanics. The theoretical discussion is followed by a detailed description of the experimental apparatus - one that allows us to isolate pairs of polystyrene spheres in an essentially two-dimensional geometry by restricting the particles to a narrow gap between parallel glass plates. Finally, we examine the results of our experiments and compare our findings with theoretical predictions.

31117 (IC–95/102) **Multisite antiferromagnetic Ising spin model: Chaos in the description of chaotic repellers.** Ananikian, N.S. (International Centre for Theoretical Physics, Trieste (Italy)); Dallakian, S.K.; Izmailian, N.Sh.; Oganessyan, K.A. International Centre for Theoretical Physics, Trieste (Italy). Jun 1995. 15p. Grant INTAS-93-633. Order Number DE96602365. Source: OSTI; NTIS (US Sales Only); INIS.

The exact connection between the Ising spin model with multisite antiferromagnetic interaction on Husimi tree in external magnetic field in the case of "fully developed chaos" and chaotic repellers (semiattractors) is obtained. The chaotic properties of this statistical mechanical system via the invariants characterizing a fractal set (e.g. a strange attractor) are described. It is shown that this system in chaotic region displays a first order phase transition at positive temperature $\beta_c = 0.89$, whereas in the fractal sets, generated by a class of maps close to $x \rightarrow 4x(1 - x)$ the phase transitions of first order occur at negative "temperature". The Frobenius-Perron recursion equation is numerically solved and the density of the invariant measure on the chaotic repeller is obtained. (author). 16 refs, 6 figs.

31118 (IC–95/121) **Schottky defect formation energy of Alkali hydrides.** Sanyal, S.P. International Centre for Theoretical Physics, Trieste (Italy). Jun 1995. 12p. Order Number DE96602366. Source: OSTI; NTIS (US Sales Only); INIS.

Schottky defect formation energies of alkali hydrides have been calculated using static simulation technique and crystal potential consisting of zero point and van der Waals interaction energies. The calculated defect energies for LiH agree reasonably well with experimental results. We emphasize the need of accurate measurements of ionic conductivity and inclusion of many body forces in these crystals. (author). 31 refs, 2 tabs.

31119 (IC–95/137) **Electronic and structural properties of MgS and MgSe.** Kalpana, G. (Anna Univ., Madras (India). Dept. of Physics); Thomas, R.M.; Rajagopalan, M.; Palanivel, B. International Centre for Theoretical Physics, Trieste (Italy). Jun 1995. 15p. Order Number DE96602367. Source: OSTI; NTIS (US Sales Only); INIS.

A detailed description of the electronic band structures of MgS and MgSe were investigated using the tight binding linear muffin-tin orbital method. The calculations were done in the zinc blende (B3) and the NaCl-type (B1) structures. The calculated ground state properties were found to be in agreement with the experimental values. Under compression both MgS and MgSe are found to undergo a structural phase transition from the B3 to the B1 structure at pressures of 377 and 317 kbar respectively. At ambient conditions MgS and MgSe are indirect band gap semiconductors and exhibit the phenomenon of metallization at about 50% volume compression. (author). 19 refs, 4 figs, 3 tabs.

31120 (LA-UR–95-1848) **Interatomic potentials for covalent materials from a local approximation to tight binding.** Voter, A.F.; Kress, J.D.; Silver, R.N. Los Alamos National Lab., NM (United States). [1995]. 7p. Sponsored by USDOE, Washington, DC (United States). DOE Contract W-7405-ENG-36. (CONF-9505249–12: 97. American Ceramic Society (ACS) annual meeting and exposition, Cincinnati, OH (United States), 2 May 1995). Order Number DE95016811. Source: OSTI; NTIS; GPO Dep.

We present a local approximation to total energy tight binding (TB) designed to be suitable as a semiempirical potential form for covalent and metallic-covalent materials. Chebyshev polynomial moments of the Hamiltonian matrix are generated in a stable and efficient manner through recursive matrix-vector multiplies. The electronic density of states is approximated by a Chebyshev polynomial expansion with Gibbs damping which maintains positivity. The scaling of the computational work is made linear in the number of atoms by truncating the moment computation at a certain range about each atom. Energy derivatives necessary for molecular dynamics are obtained from a matrix-polynomial derivative relation. The method converges to exact TB as the number of moments and the truncation range are increased. The convergence properties are tested on silicon.

31121 (LA-UR–95-2628) **Numerical anomalies mimicking physical effects.** Menikoff, R. Los Alamos National Lab., NM (United States). [1995]. 8p. Sponsored by USDOE, Washington, DC (United States). DOE Contract W-7405-ENG-36. (CONF-950846–9: American Physical Society biennial conference on shock compression of condensed matter, Seattle, WA (United States), 13-18 Aug 1995). Order Number DE95016984. Source: OSTI; NTIS; GPO Dep.

Numerical simulations of flows with shock waves typically use finite-difference shock-capturing algorithms. These algorithms give a shock a numerical width in order to generate the entropy increase that must occur across a shock wave. For algorithms in conservation form, steady-state shock waves are insensitive to the numerical dissipation because of the Hugoniot jump conditions. However, localized numerical errors occur when shock waves interact. Examples are the "excess wall heating" in the Noh problem (shock reflected from rigid wall), errors when a shock impacts a material interface or an abrupt change in mesh spacing, and the start-up error from initializing a shock as a discontinuity. This class of anomalies can be explained by the entropy generation that occurs in the transient flow when a shock profile is formed or changed. The entropy error is localized spatially but under mesh refinement does not decrease in magnitude. Similar effects have been observed in shock tube experiments with partly dispersed shock waves. In this case, the shock has a physical width due to a relaxation process. An entropy anomaly from a transient shock interaction is inherent in the structure of the conservation equations for fluid flow. The anomaly can be expected to occur whenever

heat conduction can be neglected and a shock wave has a non-zero width, whether the width is physical or numerical. Thus, the numerical anomaly from an artificial shock width mimics a real physical effect.

31122 (LA-UR–95-2834) **Giant magnetoresistance effects in 5f-materials.** Havela, L. (Charles Univ., Prague (Czech Republic)); Sechovsky, V.; Prokes, K. Los Alamos National Lab., NM (United States). [1995]. 20p. Sponsored by USDOE, Washington, DC (United States). DOE Contract W-7405-ENG-36. (CONF-9509209–2: International conference on strongly correlated electron systems, Goa (India), 27-30 Sep 1995). Order Number DE96000011. Source: OSTI; NTIS; GPO Dep.

Very large magnetoresistance effects related to reorientation of magnetic moments were observed in a number of U-intermetallics. The resemblance to magnetic multilayers is a basis of discussion of possible mechanisms of these phenomena, in background of which is probably the strong hybridization of 5f- and conduction-electron states. A clear cut evidence of relative contributions of varied scattering rate on one side and carrier concentration on the other side can be presumably obtained from experiments on samples with controlled disorder.

31123 (UCRL-JC–122170) **Shock wave measurements.** Holmes, N.C. Lawrence Livermore National Lab., CA (United States). 12 Sep 1995. 4p. Sponsored by USDOE, Washington, DC (United States). DOE Contract W-7405-ENG-48. (CONF-9509226–3: 15. Association for the International Advancement of High Pressure & Technology international conference, Warsaw (Poland), 11-15 Sep 1995). Order Number DE96000367. Source: OSTI; NTIS; GPO Dep.

Much of our knowledge of the properties of matter at high pressures, from the static ruby pressure scale to shock compression at Gbar pressures, rests ultimately on the use of shock waves. Simple conservation relations define the initial and final states, leading to absolute measurements. I will describe some methods for measuring the equation of state of materials under shock loading for a variety of methods of shock production, and also describe the basis for other optical methods used widely in shock physics.

6651 Nuclear Techniques In Condensed Matter Physics

Refer also to citation(s) 30120, 30184

31124 (IC–95/123) **A symmetry based study of positron annihilation spectra.** Adam, Gh.; Adam, S. International Centre for Theoretical Physics, Trieste (Italy). Jun 1995. 36p. Order Number DE96602373. Source: OSTI; NTIS (US Sales Only); INIS.

We describe a method for off-line analysis of spectra measured by two-dimensional angular correlation of annihilation radiation (2D-ACAR) positron spectroscopy. The method takes into account, at all its stages, two salient data features: the piecewise constant discretization of the 2D physical momentum distribution into square pixels, performed by the setup, and the occurrence of a characteristic 2D projected symmetry of the positron-electron pair momentum distribution. Several validating criteria are derived which secure significantly increased reliability of the output. The method is tested on 2D-ACAR spectra measured on (R)$Ba_2Cu_3O_{7-\delta}$(R123; R = Y, Dy) single crystals. It resolves ridge Fermi surfaces (FS) up to 3-rd Umklapp components on both kinds of R123 spectra. Moreover, on a c-axis-projected Y123 spectrum, measured at 300 K, it resolves a small but clear signature of the pillbox FS at the S point of the first Brillouin zone as well. (author). 31 refs, 12 figs, 2 tabs.

31125 (INIS-BR–3540, pp. 209-213) **Unobservability of the sign change of spinors under a 2π rotation in neutron interferometric experiments.** Maiorini, J.E. (Universidade Estadual de Campinas, SP (Brazil). Inst. de Fisica); Zeni, J.R.R.; Rodrigues Junior, W.A.R. Sociedade Brasileira de Fisica, Sao Paulo, SP (Brazil). 1993. 251p. (CONF-9109557–: 12. national meeting on particle physics and fields, Caxambu (Brazil), 18-22 Sep 1991). In *Proceedings of the 12. National Meeting on Particle Physics and Fields*. Order Number DE96602594. Source: OSTI; NTIS; INIS.

We show that the neutron interferometric experiments do not imply that the neutron wave function must be described by a Pauli c-spinor wave function that changes sign under a 2π rotation. We argue that the papers supporting the opposite view have jumbled up the time evolution of the Pauli c-spinor wave function with its transformation law under rotations. Even more, we show that the experiment can be well described using a Pauli algebraic spinor wave function that does not change sign under a 2π rotation. (author). 38 refs.

31126 (INIS-mf–14550, pp. 113) **Erbium-doped silicon - base material for IR-light sources.** Hendorfer, G. (Johannes Kepler Univ., Linz (Austria)); Jantsch, W.; Palmetshofer, L.; Przybylinska, H. Oesterreichische Physikalische Gesellschaft, Vienna (Austria). 1994. 198p. (In German). (CONF-9409362–: 44. annual convention of the Austrian Physical Society, Innsbruck (Austria), 19-23 Sep 1994). In *44th Annual Convention of the Austrian Physical Society*. Order Number DE95634610. Source: OSTI; NTIS (US Sales Only); INIS.

Short communication. ELECTRON SPIN RESONANCE/ photoluminescence; ELECTRON SPIN RESONANCE/ spectroscopy; SILICON/doped materials; SILICON/erbium; CZOCHRALSKI METHOD; PHOTOLUMINESCENCE; SPECTROSCOPY; OPTICAL PROPERTIES; SEMICONDUCTOR MATERIALS; SILICON; ERBIUM

31127 (IS-T–1731) **NMR and NQR study of the thermodynamically stable quasicrystals.** Shastri, A. Ames Lab., IA (United States). 10 Feb 1995. 152p. Sponsored by USDOE, Washington, DC (United States). DOE Contract W-7405-ENG-82. Order Number DE96000223. Source: OSTI; NTIS; GPO Dep.

^{27}Al and ^{61,65}Cu NMR measurements are reported for powder samples of stable AlCuFe and AlCuRu icosahedral quasicrystals and their crystalline approximants, and for a AlPdMn single grain quasicrystal. Furthermore, ^{27}Al NQR spectra at 4.2 K have been observed in the AlCuFe and AlCuRu samples. From the quadrupole perturbed NMR spectra at different magnetic fields, and from the zero field NQR spectra, a wide distribution of local electric field gradient (EFG) tensor components and principal axis system orientations was found at the Al site. A model EFG calculation based on a 1/1 AlCuFe approximant was successful in explaining the observed NQR spectra. It is concluded that the average local gradient is largely determined by the p-electron wave function at the Al site, while the width of the distribution is due to the lattice contribution to the EFG. Comparison of ^{63}Cu NMR with ^{27}Al NMR shows that the EFG distribution at the two sites is similar, but that the electronic contribution to the EFG is considerably smaller at the Cu site, in agreement with a more s-type wave function of the conduction electrons.

31128 (LA-UR–95-2937) **The MCLIB library: Monte Carlo simulation of neutron scattering instruments.** Seeger, P.A. Los Alamos National Lab., NM (United States). [1995]. 60p. Sponsored by USDOE, Washington, DC (United States). DOE Contract W-7405-ENG-36. (CONF-9510212–1: 13. International collaboration on advanced neutron sources, Villigen (Switzerland), 11-14 Oct 1995). Order Number DE96000042. Source: OSTI; NTIS; INIS; GPO Dep.

Monte Carlo is a method to integrate over a large number of variables. Random numbers are used to select a value for each variable, and the integrand is evaluated. The process is repeated a large number of times and the resulting values are averaged. For a neutron transport problem, first select a neutron from the source distribution, and project it through the instrument using either deterministic or probabilistic algorithms to describe its interaction whenever it hits something, and then (if it hits the detector) tally it in a histogram representing where and when it was detected. This is intended to simulate the process of running an actual experiment (but it is much slower). This report describes the philosophy and structure of MCLIB, a Fortran library of Monte Carlo subroutines which has been developed for design of neutron scattering instruments. A pair of programs (LQDGEOM and MC_RUN) which use the library are shown as an example.

31129 (LNS–177) **Structural, optical and spectroscopical investigations into rare-earths perowskites $RGaO_3$ (R=La, Pr, Nd) and NdBa-$2Cu_3O_{7-\delta}$.** Marti, W. (Paul Scherrer Inst. (PSI), Villigen (Switzerland)). Eidgenoessische Technische Hochschule,

Zurich (Switzerland). Lab. fuer Neutronenstreuung. Jul 1995. 117p. (In German). Order Number DE96602924. Source: OSTI; NTIS; INIS.

In this work I was engaged in rare-earth perovskites. Primarily I investigated the structure of the rare-earth gallates $RGaO_3$ (R=La, Pr, Nd) as a function of the temperature by means of neutron diffraction and x-ray diffraction. As the high-T_c superconductors these compounds belong to the family of the perovskites, they are ferroelastic and centro-symmetric. Because of the lanthanide-contraction all lattice constants and distortion parameters change systematically. The rare-earth-gallates $RGaO_3$ (R=La, Pr, Nd) are promising substrates for epitaxy of high-T_c superconductors like $RBa_2Cu_3OO_{7-\delta}$ because of their structure parameters and expansion coefficients. I succeeded in producing plane-parallel single-domain crystals by means of uniaxial stress. The first order phase transition was observable only in $LaGaO_3$. A structurally phase transition from orthorhombic to rhombohedral symmetry (high-temperature phase) occurs at 423 K. The hysteresis of the phase transition temperature of about 1.5 K was measured with single-domain crystals by means of neutron diffraction and polarized light microscopy. In $NdGaO_3$ we determined the long-range, three-dimensional, antiferromagnetic ordering of the Nd^{3+}-ions below the ordering temperature at T_N=0.97 K by means of magnetic neutron diffraction. The spin configuration could be described by a ($-c_z$)-mode. Measurements of the magnetic susceptibility confirm the easy direction of magnetization to be the c-axis. Below 300mK an additional nuclear spin polarization due to the hyperfine-interaction appears parallel to the electronic spins, which amounts to 70% at 10mK. Further I investigated the optical properties of the rare-earth gallates. The birefringence of plane-parallel, polished single-domain crystals with thickness up to 300 μm was measured by means of orthoscopy and conoscopy. (author) figs., tabs., refs.

31130 (SLAC–423) **The Si(100)-Sb 2×1 and Ge(100) 2×1 surfaces: A multi-technique study.** Richter, M. Stanford Linear Accelerator Center, Menlo Park, CA (United States). Aug 1993. 99p. Sponsored by USDOE, Washington, DC (United States). DOE Contract AC03-76SF00515. (SLAC/SSRL–0057). Order Number DE95016467. Source: OSTI; NTIS; INIS; GPO Dep.

The electronic and geometric structures of the clean and Sb terminated Si(100)2×1 and Ge(100)-2×1 surfaces have been investigated using a multi-technique approach. Low energy electron diffraction (LEED), scanning tunneling microscopy (STM), surface extended X-ray absorption fine structure (SEXAFS) spectroscopy and angle-integrated core-level photoemission electron spectroscopy (PES) were employed to measure the surface symmetry, defect structure, relevant bond lengths, atomic coordination and electronic structure. By employing a multi-technique approach, it is possible to correlate changes in the geometric structure to specific features of the core-level lineshape of the substrate. This allows for the assignment of components of the core-level lineshape to be assigned to specific surface and near-surface atoms.

31131 (SLAC–438) **X-ray standing wave study of the Bi/GaAs and Bi/GaP interfaces.** Herrera-Gomez, A. Stanford Univ., CA (United States). Apr 1994. 216p. Sponsored by USDOE, Washington, DC (United States). DOE Contract AC03-76SF00515. Order Number DE95014374. Source: OSTI; NTIS; INIS; GPO Dep.

Interfaces are one of the most important elements determining the characteristics of electronic devices. Composite semiconductors, specifically the III-V family, are technologically attractive because of their mobility and optical properties, and also because they offer the possibility of engineering such properties as the size of the band gap. Nevertheless, Si has remained the most utilized semiconductor material, primarily because the fabrication of practical MOSFETs with III-V semiconductors remains elusive. Examples of such complex interfaces are the structures formed by one monolayer of Bi on the (110) surface of GaAs and GaP. While better matched Column V elements form epitaxial continuous monolayers on III-V semiconductor (110) surfaces, Bi is too large to accommodate on GaAs and GaP surfaces with long range order, and vacancies appear to allow relaxation. For the ideal systems, symmetry imposes the presence of only two nonequivalent adatom sites. However, for Bi/GaAs and Bi/GaP, more than two different sites are present because the position of Bi atoms next to a vacancy is not necessarily equivalent to that between other Bi atoms. The geometry of the Bi/GaAs and Bi/GaP systems was determined here by triangulating XSW results from three Bragg planes. A methodology was developed that provides an intrinsic check of the validity of assuming two sites for the overlayer structures. An experimental method was developed that allows the three reflections to be measured on the same sample, thus reducing the number of experimental variables, such as the degree of disorder. The traditional method of analysis was not accurate enough for this data, so a more reliable and faster method of data fitting was developed. A configuration used in the present work, which previously has been widely used, presents an intrinsic multireflection problem. This issue is discussed in depth, and the appropriate method is determined for analyzing the data obtained with this configuration.

31132 (UM-P–94/29) **Inversion of electron scattering intensity for crystal structure analysis.** Spargo, A.E.C.; Beeching, M.J.; Allen, L.J. Melbourne Univ., Parkville, VIC (Australia). School of Physics. [1995]. 11p. Order Number DE96602925. Source: OSTI; NTIS; INIS.

The validity domain of a recently proposed iterative scheme for the inversion of the wavefunction of fast electrons after dynamical diffraction in a crystal is investigated by Bloch wave analysis. It is shown that the scheme fails when the thickness of the crystal is such that the scattering is sufficiently strong for dominant Bloch wave structure to appear in the wavefunction. The scheme could still be useful, however, in extending the range of interpretable resolution and specimen thickness for which electron scattering can be applied to crystal structure analysis. 11 refs., 1 tab., 3 figs.

6652 Solid-State Plasma

31133 (DOE/ET/53088–716) **Beat-wave generation of plasmons in semiconductor plasmas.** Berezhiani, V.I. (International Centre for Theoretical Physics, Trieste (Italy)); Mahajan, S.M. Texas Univ., Austin, TX (United States). Inst. for Fusion Studies. Aug 1995. 10p. Sponsored by USDOE, Washington, DC (United States). DOE Contract FG05-80ET53088. Order Number DE96000246. Source: OSTI; NTIS; INIS; GPO Dep.

It is shown that in semiconductor plasmas, it is possible to generate large amplitude plasma waves by the beating of two laser beams with frequency difference close to the plasma frequency. For narrow gap seimconductors (for example n-type InSb), the system can simulate the physics underlying beat wave generation in relativistic gaseous plasmas.

6653 Interactions Between Beams and Condensed Matter

Refer also to citation(s) 30150, 30196, 30361

31134 (DOE/ER/75707–T1) **Multigroup discrete ordinates solution of Boltzmann-Fokker-Planck equations and cross section library development of ion transport.** Prinja, A.K. New Mexico Univ., Albuquerque, NM (United States). Dept. of Chemical and Nuclear Engineering. Aug 1995. 37p. Sponsored by USDOE, Washington, DC (United States). DOE Contract FG02-92ER75707 ; FG03-93ER75881. Order Number DE96000289. Source: OSTI; NTIS; INIS; GPO; GPO Dep.

We have developed and successfully implemented a two-dimensional bilinear discontinuous in space and time, used in conjunction with the S_N angular approximation, to numerically solve the time dependent, one-dimensional, one-speed, slab geometry, (ion) transport equation. Numerical results and comparison with analytical solutions have shown that the bilinear-discontinuous (BLD) scheme is third-order accurate in the space ad time dimensions independently. Comparison of the BLD results with diamond-difference methods indicate that the BLD method is both quantitavely and qualitatively superior to the DD scheme. We note that the form of the transport operator is such that these conclusions carry over to energy dependent problems that include the constant-slowing-down-approximation term, and to multiple space dimensions or combinations thereof. An optimized marching or inversion scheme or a parallel algorithm should be investigated to

determine if the increased accuracy can compensate for the extra overhead required for a BLD solution, and then could be compared to other discretization methods such as nodal or characteristic schemes.

31135 (LA-SUB–95-172) **Thermoacoustic imaging using heavy ion beams.** Claytor, T.N.; Tesmer, J.R.; Deemer, B.C.; Murphy, J.C. Los Alamos National Lab., NM (United States). [1995]. 97p. Sponsored by USDOE, Washington, DC (United States). DOE Contract W-7405-ENG-36. Order Number DE96000860. Source: OSTI; NTIS; GPO Dep.

Ion beams have been used for surface modification, semiconductor device fabrication and for material analysis, which makes ion-material interactions of significant importance. Ion implantation will produce new compositions near the surface by ion mixing or directly by implanting desired ions. Ions exchange their energy to the host material as they travel into the material by several different processes. High energy ions ionize the host atoms before atomic collisions transfer the remaining momentum and stop the incident ion. As they penetrate the surface, the low energy ions ionize the host atoms, but also have a significantly large momentum transfer mechanism near the surface of the material. This leads to atoms, groups of atoms and electrons being ejected from the surface, which is the momentum transfer process of sputtering. This talk addresses the acoustic waves generated during ion implantation using modulated heavy ion beams. The mechanisms for elastic wave generation during ion implantation, in the regimes where sputtering is significant and where implantation is dominant and sputtering is negligible, has been studied. The role of momentum transfer and thermal energy production during ion implantation was compared to laser generated elastic waves in an opaque solid as a reference, since laser generated ultrasound has been extensively studied and is fairly well understood. The thermoelastic response dominated in both high and low ion energy regimes since, apparently, more energy is lost to thermal heat producing mechanisms than momentum transfer processes. The signal magnitude was found to vary almost linearly with incident energy as in the laser thermoelastic regime. The time delays for longitudinal and shear waves-were characteristic of those expected for a purely thermal heating source. The ion beams are intrinsically less sensitive to the albedo of the surface.

31136 (UM-P–94/40) **Interaction delocalization in characteristic X-ray emission from light elements.** Allen, L.J. (Melbourne Univ., Parkville, VIC (Australia). School of Physics); Josefsson, T.W.; Rossouw, C.L. Melbourne Univ., Parkville, VIC (Australia). School of Physics. [1995]. 19p. Sponsored by Australian Research Council, Canberra, ACT (Australia). Order Number DE96602958. Source: OSTI; NTIS; INIS.

Experimental results for characteristic X-ray emission in spinel are reported. Calculations of ionization cross sections and the effective ionization potential for each of the constituent atoms of the spinel $MgAl_8O_4$ have been carried out. This allows a quantitative theoretical insight into the channelling effect for the light elements Al, Mg and O which incorporates delocalization of the ionization interaction. 33 refs., 6 figs.

31137 (UM-P–94/88) **Chemical vapor deposition of diamond onto iron based substrates. The use of barrier layers.** Weiser, P.S.; Prawer, S. Melbourne Univ., Parkville, VIC (Australia). School of Physics. [1995]. 13p. Order Number DE96602959. Source: OSTI; NTIS; INIS.

When Fe is exposed to the plasma environment suitable for the chemical vapor deposition (CVD) of diamond, the surface is rapidly covered with a thick layer graphitic soot and C swiftly diffuses into the Fe substrate. Once the soot reaches a critical thickness, diamond films nucleate and grow on top of it. However, adhesion of the film to the substrate is poor due to the lack of structural integrity of the soot layer, A thin coating of TiN on the Fe can act to prevent diffusion and soot formation. Diamond readily grows upon the TiN via an a-C interface layer, but the a-C/TiN interface is weak and delamination occurs at this interface. In order to try and improve the adhesion, the use of a high dose Ti implant was investigated to replace the TiN coating. 7 refs., 6 figs.

31138 (UM-P–94/94) **Ion beam modification of buckminsterfullerene.** Prawer, S. (Melbourne Univ., Parkville, VIC (Australia). School of Physics); Nugent, K.W.; Biggs, S.; McCulloch, D.G.; Leong, W.H.; Hoffman, A.; Kalish, R. Melbourne Univ., Parkville, VIC (Australia). School of Physics. [1995]. 29p. Sponsored by Australian Research Council, Canberra, ACT (Australia);Department of Industry, Technology and Regional Development, Canberra, ACT (Australia). Generic Industry Research and Development Board. Order Number DE96602960. Source: OSTI; NTIS; INIS.

The response of thin films of buckminsterfullerene (C_{60}) to energetic xenon ion impact is investigated. The diagnostics employed include Fourier Transform Infrared and Raman Spectroscopies, Cross-Sectional Transmission Electron Microscopy, and Atomic Force Microscopy. By combining the information obtained from these diagnostics with that from the dependence of the conductivity on ion dose, it is concluded that each C_{60} molecule completely disintegrates when hit by an energetic ion. The cross-section for the destruction of about 7×10^{-13} cm ^{2} for irradiation with 620 keV Xe ions. The disintegration occurs when C atoms are knocked-out of the molecule either directly by the impinging ion or by an energetic knock-on C atom with the damage cascade. This process is quite different from the Coulomb Explosion mechanism previously proposed in the literature. For very low ions doses ($< 1 \times 10^{11}$ Xe/cm^2) most of the C_{60} molecules remain intact; however this dose is sufficient to completely disrupt the ordering of the C_{60} molecules in the van der Waals bonded C_{60} solid. Disruption of the lattice ordering at such low doses is considered to be attributable to the weakness of the van der Waals forces which bind the C_{60} clusters together into the molecular solid. 13 refs., 7 figs.

31139 (UM-P–95/26) **Inelastic scattering of fast electrons by crystals.** Allen, L.J.; Josefsson, T.W. Melbourne Univ., Parkville, VIC (Australia). School of Physics. 23 Feb 1995. 36p. Sponsored by Australian Research Council, Canberra, ACT (Australia). Order Number DE96602961. Source: OSTI; NTIS; INIS.

Generalized fundamental equations for electron diffraction in crystals, which include the effect of inelastic scattering described by a nonlocal interaction, are derived. An expression is obtained for the cross section for any specific type of inelastic scattering (e.g. inner-shell ionization, Rutherford backscattering). This result takes into account all other (background) inelastic scattering in the crystal leading to absorption from the dynamical Bragg-reflected beams, in practice mainly due to thermal diffuse scattering. There is a contribution to the cross section from all absorbed electrons, which form a diffuse background, as well as from the dynamical electrons. The approximations involved, assuming that the interactions leading to inelastic scattering can be described by a local potential are discussed, together with the corresponding expression for the cross section. It is demonstrated by means of an example for K-shell electron energy loss spectroscopy that nonlocal effects can be significant. 47 refs., 4 figs.

6654 Quantum Physics Aspects of Condensed Matter

31140 (IC–95/124) **An augmented-space recursion in the k-space representation.** Biswas, P. (Satyendranath Bose National Centre for Basic Sciences, Calcutta (India)); Sanyal, B.; Fakhruddin, M.; Halder, A.; Mookerjee, A.; Ahmed, M. International Centre for Theoretical Physics, Trieste (Italy). Jun 1995. 9p. Order Number DE96602437. Source: OSTI; NTIS (US Sales Only); INIS.

We present here a technique for the calculation of configurationally averaged quantities in reciprocal k- space representation, like the spectral function and complex band structures. We apply the technique to AgPd alloys in conjunction with the tight-binding linearized muffin tin orbitals basis. We also indicate why the same technique is ideal for application to the more accurate screened-KKR and allows us to go beyond the single site coherent potential approximation and include multi site effects like short-ranged ordering and local lattice distortions due to size mismatch of the constituent atoms. (author). 10 refs, 2 figs.

31141 (IC–95/141) **The magnetism of 3d impurities in alkali metals.** Elzain, M.E. (International Centre for Theoretical Physics, Trieste (Italy)); Yousif, A.A. International Centre for Theoretical Physics, Trieste (Italy). Jul 1995. 14p. Order Number DE96602438. Source: OSTI; NTIS (US Sales Only); INIS.

Cluster calculation of the spin local magnetic moment of Fe in alkali metals is performed. A large Fe moment is retained, independent of the cluster size, even under relatively large compressions. The Fe 3d majority sub-band for both E_g and T_{2g} symmetries are full indicating a larger magnetic exchange splitting than the crystal field as has been confirmed by direct computation. The 3d local density of states at Fe site is found to consist of a single narrow, structureless peak independent of the alkali matrix; however, a small split appears in the minority subband in the case of Li and under compression in other metals. The bond order between the 3d atom and the neighbouring alkali atoms is found to be vanishingly small for the majority electrons whereas the minority electrons retain a large value. The magnetic hyperfine field at Fe site, due to spin contact term, is found to be positive in spite of the large local moment. This is attributed to the cancellation resulting from the large positive valence contribution. The local magnetic moment and exchange splitting at 3d impurities in Na show a maximum at Cr and their ratio which give the exchange integral increases from about 0.7 eV/μ_B at Sc to about 0.9 eV/μ_B at Ni. The Stoner type criterion is consistent with the retained local magnetic moment. (author). 13 refs, 3 figs, 1 tab.

31142 (IC–95/153) **Modified finite-size scaling for anharmonic crystal with quantum fluctuations.** Pisanov, E.S. (International Centre for Theoretical Physics, Trieste (Italy)); Tonchev, N.S. International Centre for Theoretical Physics, Trieste (Italy). Jul 1995. 12p. Order Number DE96602966. Source: OSTI; NTIS (US Sales Only); INIS.

The modified finite-size scaling (for dimensions $d \geq d_>$, where $d_>$ is the upper critical dimensionality) is verified in close vicinity of both the classical and the quantum multicritical points by the example of a quantum model for anharmonic crystal, confined to a fully finite (block) geometry under periodic boundary conditions. Unified scaling equations corresponding to the two kinds of correlation lengths related with fixed dimensionless temperature t when the quantum parameter λ is changed, and with fixed λ when t is changed, are obtained. (author). 14 refs, 1 fig.

31143 (IC–95/154) **A loop-flip algorithm for the anisotropic quantum Heisenberg antiferromagnet.** Ying Heping. International Centre for Theoretical Physics, Trieste (Italy). Jul 1995. 8p. Order Number DE96602439. Source: OSTI; NTIS (US Sales Only); INIS.

A new scheme of the loop-cluster algorithm is proposed to simulate an anisotropic Heisenberg antiferromagnet - the XYZ model- to overcome the critical slowing down. Results of the internal energy, uniform and staggered susceptibilities, as well as some primary features of the algorithm, are presented suggesting that this quantum system may also be studied as the classical spin systems using the cluster updating techniques. (author). 17 refs, 1 fig., 3 tabs.

31144 (IC–95/156) **Density matrix renormalization group calculation of correlation functions in one dimensional Hubbard model.** Qin Shaojin (Academia Sinica, Beijing, BJ (China). Inst. of Theoretical Physics); Su Zhaobin; Liang Shoudan; Yu Lu. International Centre for Theoretical Physics, Trieste (Italy). Jul 1995. 16p. Order Number DE96602967. Source: OSTI; NTIS (US Sales Only); INIS.

We have studied correlation functions of the one dimensional Hubbard model using the density-matrix numerical renormalization group approach. The singularity exponents of the momentum distribution at $k = k_F$ and $k = 3k_F$, as well as the power-law singularity of the spin correlation function are computed for large U (U/t = 10^3). The momentum distribution exponent at $k = k_F$ and the spin correlation exponent are in agreement with the analytic results, while the calculated exponent for momentum distribution at $k = 3k_F$ is about 3/4 which disagrees with the analytical predicted value 9/8. We also discuss several new techniques for an accurate calculation of the correlation functions. (author). 16 refs, 5 figs, 1 tab.

31145 (IC–95/181) **Thermodynamical properties of random spin-1/2 XY chain with Dzyaloshinskii-Moriya interaction.** Derzhko, O. (International Centre for Theoretical Physics, Trieste (Italy)); Krokhmalskii, T.; Verkholyak, T. International Centre for Theoretical Physics, Trieste (Italy). Jul 1995. 7p. Order Number DE96602968. Source: OSTI; NTIS (US Sales Only); INIS.

For computation of the equilibrium statistical properties of finite spin-1/2 XY chains with Dzyaloshinskii-Moriya interaction the suggested earlier approach (JMMM 140-144 (1995) 1623) is generalized. It is applied for calculation of transverse dynamical susceptibility of spin-1/2 Ising chain in non-random and random Gaussian transverse field with Dzyaloshinskii-Moriya interaction. (author). 7 refs, 2 figs.

31146 (IC–95/182) **1D spin-1/2 XY models as a testing ground for spin systems theory methods.** Derzhko, O. (International Centre for Theoretical Physics, Trieste (Italy)); Verkholyak, T. International Centre for Theoretical Physics, Trieste (Italy). Jul 1995. 10p. Order Number DE96602969. Source: OSTI; NTIS (US Sales Only); INIS.

Elementary excitation energy spectrum that gives thermodynamic properties is calculated for few partial non-random and random versions of 1D spin-1/2 XY model. The exact result obtained is compared with the results derived within some well known approximate approaches that permits to understand the region of their validity. (author). 6 refs, 6 figs.

31147 (IC–95/183) **The variation of the mean "size" of polyatomic boxes versus temperature: A Monte-Carlo simulation. (A one-dimensional lattice binary mixture).** Mejdani, R. (International Centre for Theoretical Physics, Trieste (Italy)); Borici, A.; Kasa, A.; Gjonaj, E. International Centre for Theoretical Physics, Trieste (Italy). Jul 1995. 11p. Order Number DE96602970. Source: OSTI; NTIS (US Sales Only); INIS.

By Monte-Carlo simulations, we have studied the variation of the mean number of atoms in polyatomic boxes or the mean "size" of chain-propagating atoms and chain-terminating atoms on a one-dimensional lattice, with respect to the temperature, for different concentrations and interaction constants. The comparison of this average parameter and its variation for the asymmetric system to those of the symmetric systems allows one to state that, for asymmetric binary (one-dimensional) systems, in which two types of atom do not form the same number of bonds, the asymmetry of bonds plays its role in determining the mean "size" of boxes. The same results we have obtained before analytically, in the following way, besides its didactical values for the application of "the numerical concepts", it will help also as a calibration procedure for determining numerically the mean "size" of polyatomic boxes in two- or three-dimensional structures, where an analytical treatment is quite complicated. This could be very useful for glass-like structure investigations. (author). 10 refs, 4 figs.

31148 (IC–95/194) **Conductance fluctuations and distribution in disordered chains in presence of an electric field.** Senouci, K. (Department de Physique, Oran El M'naouer (Algeria). Lab. de Physique Electronique des Solides); Zekri, N.; Ouasti, R. International Centre for Theoretical Physics, Trieste (Italy). Jul 1995. 19p. Order Number DE96602971. Source: OSTI; NTIS (US Sales Only); INIS.

A simple Kronig-Penney model for 1D mesoscopic systems with disordered δ-peak and finite width potentials under an electric field is used to study the conductance fluctuations and distributions in different phase states. The electric field allows us to obtain the insulating, transition and metallic regimes. In the superlocalized electron states found previously near the Brillouin zone edges of the corresponding periodic system the conductance fluctuations are smaller than those of the insulating regime corresponding to the vanishing field, but the conductance probability distribution has a similar behaviour. Extensive results are compared to the previous works on higher dimensions and quasi-1D mesoscopic systems in each regime and found to be in good agreement. Further discussions are also included. (author). 33 refs, 11 figs.

665410 Superconductivity

Refer also to citation(s) 30033, 30102, 30113, 30491, 31124, 31230

31149 (CONF-940627–Vol.2) **Proceedings of the fourth international conference and exhibition: World Congress on superconductivity. Volume 2.** Krishen, K. (National Aeronautics and Space Administration, Houston, TX (United States). Lyndon B. Johnson Space Center); Burnham, C. (eds.). National Aeronautics

and Space Administration, Washington, DC (United States); National Aeronautics and Space Administration, Houston, TX (United States). Lyndon B. Johnson Space Center. 1994. 400p. Sponsored by National Aeronautics and Space Administration, Washington, DC (United States). From 4. international conference and exhibition of the World Congress on Superconductivity; Orlando, FL (United States); 27 Jun - 1 jul 1994. Source: OSTI; NASA Center for AeroSpace Information, 800 Elkridge Landing Road, Linthicum Heights, MD 21090-2934 (United States).

This document contains papers presented at the 4th International Conference Exhibition: World Congress on Superconductivity held at the Marriott Orlando World Center, Orlando, Florida, June 27–July 1, 1994. This conference encompassed research, technology, applications, funding, political, and social aspects of superconductivity. Specifically, the areas of research, technology, and development covered during the conference included high-temperature materials, thin films, C-60 based superconductors, persistent magnetic fields and shielding, fabrication methodology, space applications, physical applications, performance characterization, device applications, weak link effects and flux motion, accelerator technology, superconductivity energy, storage, future research and development directions, medical applications, granular superconductors, wire fabrication technology, computer applications, technical and commercial challenges, and power and energy applications. The key objective of this conference was to provide a forum for the world community to share technological results of recent advances made in the field of superconductivity and to discuss translation of the research to technology which will benefit humanity. More than 150 presentations were made at this conference. Individual papers are indexed separately on the Energy Data Bases.

31150 (KRC–88S-J10) **Development of a 20KVA Superconducting Alternator.** Chang, J.K. (Korea Electric Power Corp. (KEPCO), Taejon (Korea, Republic of). Research Center); Namkung, D.; Lee, W.H.; Choi, I.H.; Han, S.Y.; Han, D.C.; Ko, T.K.; Sin, H.C.; Cha, G.S.; Jo, J.W.; Han, S.J.; Choi, K.D.; Kim, D.H.; Lee, S.J.; Lee, Y.H.; Kim,Korea Electric Power Corp. (KEPCO), Taejon (Korea, Republic of). Research Center. 1994. 169p. (In Korean). Order Number DE96703604. Source: OSTI; NTIS (US Sales Only).

The commercial power generator using superconducting alternators will be possible around 2010. Thin it is necessary to prepare for basic superconducting technologies and production of many researchers who will engage in superconducting technologies. The objective of this study is firstly to develop analysis and design techniques for superconducting generators. And secondly it is to establish manufacturing techniques of various elements of superconducting generator. A 20KVA superconducting generator is designed and fabricated to improve the effectiveness of the developed techniques. (author). 37 refs.

31151 (LA-UR–95-2461) **Assembly and testing of a composite heat pipe thermal intercept for HTS current leads.** Daugherty, M.A.; Daney, D.E.; Prenger, F.C.; Hill, D.D.; Williams, P.M.; Boenig, H.J. Los Alamos National Lab., NM (United States). [1995]. 5p. Sponsored by USDOE, Washington, DC (United States). DOE Contract W-7405-ENG-36. (CONF-950722–7: Cryogenic engineering conference and international cryogenic materials conference, Columbus, OH (United States), 17-21 Jul 1995). Order Number DE95016914. Source: OSTI; NTIS; GPO Dep.

We are building high temperature superconducting (HTS) current leads for a demonstration HTS-high gradient magnetic separation (HGMS) system cooled by a cryocooler. The current leads are entirely conductively cooled. A composite nitrogen heat pipe provides efficient thermal communication, and simultaneously electrical isolation, between the lead and an intermediate temperature heat sink. Data on the thermal and electrical performance of the heat pipe thermal intercept are presented. The electrical isolation of the heat pipe was measured as a function of applied voltage with and without a thermal load across the heat pipe. The results show the electrical isolation with evaporation, condensation and internal circulation taking place in the heat pipe.

31152 (UCRL-ID–121173) **Development of multielement SQUID arrays for magnetic source imaging. Final report.** Hassenzahl, W.V.; Casper, T.A.; Miller, D.E. Lawrence Livermore National Lab., CA (United States). Jun 1995. 3p. Sponsored by USDOE, Washington, DC (United States). DOE Contract W-7405-ENG-48. Order Number DE96000376. Source: OSTI; NTIS; GPO Dep.

Superconducting quantum interference devices (SQUIDs) were initially developed in the late 1960s as biomagnetic detectors to monitor electrical activity in the body. Research in this area has increased in recent years as electronics and computer diagnositcs have improved. The basis of this proposal was to asses: (1) the advantages of using this technique over other technologies and (2) the requirements for development of a complete system that would advance the state of the art. In our assessment of this technology, we collaborated with the Medical School at the University of California, San Francisco (UCSF), General Electric (GE), Biomagnetic Technologies (BTi), and Conductus, each of which has unqiue expertise in biomedical applications. UCSF is one of the foremost clinical institutions in the US developing imaging techniques. GE is the primary US supplier of medical imaging systems. Conductus is the major US supplier of SQUIDs and BTi is a developer of SQUID array systems.

665420 Superfluidity

31153 (SAND–95-1385C) **Cryogenic design of the liquid helium experiment "critical dynamics in microgravity".** Moeur, W.A. (New Mexico Univ., Albuquerque, NM (United States)); Adriaans, M.J.; Boyd, S.T.; Strayer, D.M.; Duncan, R.V. Sandia National Labs., Albuquerque, NM (United States). [1995]. 22p. Sponsored by National Aeronautics and Space Administration, Washington, DC (United States). DOE Contract AC04-94AL85000. (CONF-9507176–1: Space cryogenics workshop, Greenbelt, MD (United States), 25-26 Jul 1995). Order Number DE96000785. Source: OSTI; NTIS; GPO Dep.

Although many well controlled experiments have been conducted to measure the static properties of systems near criticality, few experiments have explored the transport properties in systems driven far away from equilibrium as a phase transition occurs. The cryogenic design of an experiment to study the dynamic aspect of critical phenomena is reported here. Measurements of the thermal gradient across the superfluid (He II) – normal fluid (He I) interface in helium under microgravity conditions will be performed as a heat flux holds the system away from equilibrium. New technologies are under development for this experiment, which is in the definition phase for a space shuttle flight.

70 PLASMA PHYSICS AND FUSION

Refer also to citation(s) 31056, 31057, 31061, 31062

7003 Plasma Physics and Fusion Research

Refer also to citation(s) 29977, 30101, 30161, 30289, 30913, 31208, 31212, 31213

31154 (ANL/FPP/TM–285) **Modelling multi-ion plasma gun simulations of Tokamak disruptions.** Ehst, D.A. Argonne National Lab., IL (United States). Aug 1995. 17p. Sponsored by USDOE, Washington, DC (United States). DOE Contract W-31109-ENG-38. Order Number DE96000180. Source: OSTI; NTIS; INIS; GPO Dep.

The effect of impurity ions in plasma gun ablation tests of various targets is considered. Inclusion of reasonable amounts of impurity (~10%) is adequate to explain observed energy transmission and erosion measurements. The gun tests and the computer code calculations are relevant to the parameter range expected for major disruptions on large tokamaks.

31155 (CONF-941182–5) **ICRF heating and transport of deuterium-tritium plasmas in TFTR.** Murakami, M. (Oak Ridge National Lab., TN (United States)); Batchelor, D.B.; Bush, C.E. Oak Ridge National Lab., TN (United States); Princeton Univ., NJ (United States). Plasma Physics Lab. [1994]. 8p. Sponsored by

USDOE, Washington, DC (United States). DOE Contract AC05-84OR21400 ; AC02-76CH03073. From 6. international Toki conference on plasma physics and controlled nuclear fusion: Research for advanced concepts in magnetic fusion; Toki-city (Japan); 29 Nov - 2 dec 1994. Order Number DE95017443. Source: OSTI; NTIS; INIS; GPO Dep.

This paper describes results of the first experiments utilizing high-power ion cyclotron range of frequency (ICRF) to heat deuterium-tritium (D-T) plasmas in reactor-relevant regimes on the Tokamak Fusion Test Reactor (TFTR). Results from these experiments have demonstrated efficient core, second harmonic, tritium heating of D-T supershot plasmas with tritium concentrations ranging from 6%–40%. Significant direct ion heating on the order of 60% of the input radio frequency (rf) power has been observed. The measured deposition profiles are in good agreement with two-dimensional modeling code predictions. Confinement in an rf-heated supershot is at least similar to that without rf, and possibly better in the electron channel. Efficient electron heating via mode conversion of fast waves to ion Bernstein waves (IBW) has been demonstrated in ohmic, deuterium-deuterium and DT-neutral beam injection plasmas with high concentrations of minority ^{3}He ($n_{^3He}/n_e$ > 10%). By changing the ^{3}He concentration or the toroidal field strength, the location of the mode-conversion radius was varied. The power deposition profile measured with rf power modulation showed that up to 70% of the power can be deposited on electrons at an off-axis position. Preliminary results with up to 4 MW coupled into the plasma by 90-degree phased antennas showed directional propagation of the mode-converted IBW. Heat wave propagation showed no strong inward thermal pinch in off-axis heating of an ohmically-heated (OH) target plasma in TFIR.

31156 (CONF-9505105–16) **ICRF heating on helical devices.** Rasmussen, D.A. (and others); Lyon, J.F.; Hoffman, D.J. Oak Ridge National Lab., TN (United States). [1995]. 4p. Sponsored by USDOE, Washington, DC (United States). DOE Contract AC05-84OR21400. From 11. topical conference on radio frequency in plasmas; Palm Springs, CA (United States); 17-19 May 1995. Order Number DE95017386. Source: OSTI; NTIS; INIS; GPO Dep.

Ion cyclotron range of frequency (ICRF) heating is currently in use on CHS and W7AS and is a major element of the heating planned for steady state helical devices. In helical devices, the lack of a toroidal current eliminates both disruptions and the need for ICRF current drive, simplifying the design of antenna structures as compared to tokamak applications. However the survivability of plasma facing components and steady state cooling issues are directly applicable to tokamak devices. Results from LHD steady state experiments should be available on a time scale to strongly influence the next generation of steady state tokamak experiments. The helical plasma geometry provides challenges not faced with tokamak ICRF heating, including the potential for enhanced fast ion losses, impurity accumulation, limited access for antenna structures, and open magnetic field lines in the plasma edge. The present results and near term plans provide the basis for steady state ICRF heating of larger helical devices. An approach which includes direct electron, mode conversion, ion minority and ion Bernstein wave heating addresses these issues.

31157 (CONF-9505254–4) **ICRF heating on helical devices.** Rasmussen, D.A.; Lyon, J.F.; Hoffman, D.J.; Murakami, M.; England, A.C.; Wilgen, J.B.; Jaeger, E.F.; Wang, C.; Batchelor, D.B. Oak Ridge National Lab., TN (United States). [1995]. 5p. Sponsored by USDOE, Washington, DC (United States). DOE Contract AC05-84OR21400. From International stellarator workshop; Madrid (Spain); 22-26 May 1995. Order Number DE95017385. Source: OSTI; NTIS; INIS; GPO Dep.

Ion cyclotron range of frequency (ICRF) heating is currently in use on CHS and W7-AS and is a major element of the heating planned for steady state helical devices. In helical devices, the lack of a toroidal current eliminates both disruptions and the need for ICRF current drive, simplifying the design of antenna structures as compared to tokamak applications. However the survivability of plasma facing components and steady state cooling issues are directly applicable to tokamak devices. Results from LHD steady state experiments should be available on a time scale to strongly influence the next generation of steady state tokamak experiments. The helical plasma geometry provides challenges not faced with tokamak ICRF heating, including the potential for enhanced fast ion losses, impurity accumulation, limited access for antenna structures, and open magnetic field lines in the plasma edge. The present results and near term plans provide the basis for steady state ICRF heating of larger helical devices. An approach which includes direct electron, mode conversion, ion minority and ion Bernstein wave heating addresses these issues.

31158 (DOE/ER/54169–T1) **Thomson scattering diagnostic analyses to determine the energetic particle distributions in TFTR. Final report.** Aamodt, R.E.; Cheung, P.Y.; Russell, D.A. Lodestar Research Corp., Boulder, CO (United States). 16 Feb 1995. 25p. Sponsored by USDOE, Washington, DC (United States). DOE Contract FG02-92ER54169. (LRC–95-48). Order Number DE96000910. Source: OSTI; NTIS; INIS; GPO Dep.

Lodestar has been an active participant in the low power Collective Thomson Scattering (CTS) diagnostic at TFTR in collaboration with MIT. Extensive studies were conducted regarding the use of gyrotron scattering as a low cost diagnostic for both energetic ions and alpha particles on TFTR. The numerical scattering code has been improved and compared with similar code developed at JET. The authors have participated and assisted in the CTS experiments through onsite visits and have successfully performed most of the data analysis tasks remotely. Through their analysis on the initial data base accumulated, they are able to understand qualitatively the general features of the anomalous large scattered signal, have proposed an explanation for its generation mechanism, and have suggested a potential new use of CTS as an edge diagnostic.

31159 (DOE/ET/53088–717) **Spectrum of Alfven waves, a brief review.** Mahajan, S.M. Texas Univ., Austin, TX (United States). Inst. for Fusion Studies. Sep 1995. 42p. Sponsored by USDOE, Washington, DC (United States). DOE Contract FG05-80ET53088. Order Number DE96000247. Source: OSTI; NTIS; INIS; GPO Dep.

Salient aspects of the Alfven wave spectrum in hot confined plasmas are presented.

31160 (DOE/OR/21400–T499) **Investigation of heterodyne performance of quantum-well detectors. Final report.** Simpson, M.L. (Oak Ridge National Lab., TN (United States)); Hutchinson, D.P.; Calabretta, J. Oak Ridge National Lab., TN (United States). 23 Sep 1994. 13p. Sponsored by USDOE, Washington, DC (United States). DOE Contract AC05-84OR21400. Order Number DE96000687. Source: OSTI; NTIS; GPO Dep.

The purpose of this Cooperative Research and Development Agreement (CRADA) between Martin Marietta Energy Systems Inc., (Contractor) and Martin Marietta Electronic Missles (Participant) is the determination of the heterodyne characteristics of quantum-well detectors. The Participant has developed a quantum-well infrared imaging video detector with very low light level characteristics. A further improvement in low-level infrared detection could be achieved if this device can be operated in the coherent or heterodyne mode. A major program in the Physics Division of Oak Ridge National Laboratory (ORNL) presently uses individual heterodyne infrared detectors in a system under development for fusion diagnostics. An imaging infrared heterodyne detector would represent a major breakthrough in this area and would have major implications for other plasma diagnostic programs. The Participant is also studying the application of this device in the area of laser radar.

31161 (GA-A–22050-Rev.1) **Electron cyclotron heating and current drive: Present experiments to ITER. Revision 1.** Harvey, R.W. (General Atomics, San Diego, CA (United States)); Nevins, W.M.; Smith, G.R.; Lloyd, B.; O'Brien, M.R.; Warrick, C.D. General Atomics, San Diego, CA (United States); Lawrence Berkeley Lab., CA (United States); Raytheon Engineers and Constructors, Inc., New York, NY (United States). Aug 1995. 10p. Sponsored by USDOE, Washington, DC (United States);Department of Trade and Industry, London (United Kingdom). DOE Contract AC03-89ER51114 ; W-7405-ENG-48 ; AC03-94SF20282. (CONF-950112–6-Rev.1: 9. joint workshop on electron cyclotron emission and electron cyclotron resonance heating, Borrego Springs, CA (United States), 23-26 Jan 1995). Order Number DE96000804. Source: OSTI; NTIS; INIS; GPO Dep.

Electron cyclotron (EC) power has technological and physics advantages for heating and current drive in a tokamak reactor, and advances in source development make it credible for applications in ITER. Strong single pass absorption makes heating to ignition particularly simple. The optimized EC current drive (ECCD) efficiency ($\langle n \rangle IR/P$) shows a linear temperature scaling at temperatures up to ~ 15 keV. For temperatures above 30 keV, the efficiency saturates at approximately $0.3 \cdot 10^{20}$ A/(m^{2}W) for a frequency of 220 GHz in an ITER target plasma with toroidal field of 6 T, due primarily to harmonic overlap [G.R. Smith et al., Phys. Fluids 30 3633 (1987)] and to a lesser extent due to limitations arising from relativistic effects [N.J. Fisch, Phys. Rev. A 24 3245 (1981)]. The same efficiency can also be obtained at 170 GHz for the same plasma equilibrium except that the magnetic field is reduced to (170/220) x 6 T = 4.6 T. The ECCD efficiencies are obtained with the comprehensive 3D, bounce-averaged Fokker-Planck CQL3D codes [R.W. Harvey and M.G. McCoy, Proc. IAEA TCM/Advances in Simulation and Modeling in Thermonuclear Plasmas 1992, Montreal], and BANDIT3D [M.R. O'Brien, M. Cox, C.D. Warrick, and F. S. Zaitsev, ibid.].

31162 (INIS-mf–14602) **Study of the striated nature of a glow discharge.** Hernandez A, M. Universidad Autonoma del Estado de Mexico, Toluca (Mexico). Escuela de Ciencias. 1995. 76p. (In Spanish). Order Number DE96602895. Source: OSTI; NTIS (US Sales Only); INIS.

In an investigation in progress here, plasma diagnostics and detection of standing and moving striations is being made in a discharge in Argon at pressures of 2 x 10^{-1} to 9 x 10^{-1} mb and currents of 2 to 9 m-amp inside an discharge tube. Measurement of the temperature of the electrons, the concentration of electrons and the plasma potential are obtained in different places of the discharge by the double probe method, together with the computation system reported in [1]. In similar way an experimental work of the striated column in a discharge plasma to find the regimen of appearance of the standing and moving striations show some properties of moving striations (frequency and velocity) and standing striations. Two different oscilations are observed in motion in contrary directions along the discharge tube with a photomultiplier. (Author).

31163 (JAERI-Conf–94-001, pp. 3-14) **Launching fast waves in large devices.** Jacquinot, J. (Commission of the Eurpean Communities, Abington (United Kingdom). JET Joint Undertaking); Bhatnagar, V.P.; Kaye, A.; Brown, T. Japan Atomic Energy Research Inst., Tokyo (Japan). Aug 1994. (CONF-9311140–: IAEA meeting on radio-frequency launchers for plasma heating and current drive, Naka (Japan), 10-12 Nov 1993). In *Proceedings of the IAEA technical committee meeting on RF launchers for plasma heating and current drive.* 168p. Order Number DE95776546. Source: OSTI; NTIS; INIS.

Design features of JET A2-antennae including that of remote location of ceramic are outlined. These antennae are being installed in preparation for the new divertor phase of JET that will commence in 1994. The experience of antenna design gained at JET is carried forward to present an outline in blanket/shield design of an antenna for launching fast waves in ITER for heating and current drive. Further, a new wide band antenna the so called 'violin antenna' is presented that features high plasma coupling resistance in selected bands in the 20-85 MHz frequency range. (author).

31164 (JAERI-Conf–94-001, pp. 15-26) **Technology development for LHD ICRF(ion cyclotron range frequencies) heating.** Watari, T. (National Inst. for Fusion Science, Nagoya (Japan)); Kumazawa, R.; Mutoh, T.; Seki, T.; Shimpo, F.; Masuda, S. Japan Atomic Energy Research Inst., Tokyo (Japan). Aug 1994. (CONF-9311140–: IAEA meeting on radio-frequency launchers for plasma heating and current drive, Naka (Japan), 10-12 Nov 1993). In *Proceedings of the IAEA technical committee meeting on RF launchers for plasma heating and current drive.* 168p. Order Number DE95776546. Source: OSTI; NTIS; INIS.

ICRF heating system for steady state operation of Large Helical Device (LHD) was developed and tested. The R and D test set which consists of a transmitter, transmission lines, a matching stub tuner, a vacuum feedthrough, a vacuum chamber, and a test antenna, have been constructed. To remove the resistive heat load generated RF current, all the components are cooled with water which circulates inside them. The structure of water inlet/outlet of the coaxial transmission lines were newly designed and tested. The coaxial line has a large diameter of 240mm in order to ensure high RF stand off voltage. The steady state operation test was carried out at 30 kW (which is equivalent to 500 kW in the heating experiment) for 30 minutes. Temperature increment of the test antenna and the outer conductors of the transmission line were measured and it was confirmed that they stay within the acceptable level. The 30 minutes test run shows that the newly designed integral components have high enough cooling capability and stand off voltage for the steady state heating experiment in the LHD. (author).

31165 (JAERI-Conf–94-001, pp. 27-36) **Fast wave current drive technology development at ORNL.** Baity, F.W. (Oak Ridge National Lab., TN (United States)); Batchelor, D.B.; Goulding, R.H. Japan Atomic Energy Research Inst., Tokyo (Japan). Aug 1994. (CONF-9311140–: IAEA meeting on radio-frequency launchers for plasma heating and current drive, Naka (Japan), 10-12 Nov 1993). In *Proceedings of the IAEA technical committee meeting on RF launchers for plasma heating and current drive.* 168p. Order Number DE95776546. Source: OSTI; NTIS; INIS.

The technology required for fast wave current drive (FWCD) systems is discussed. Experiments are underway on DIII-D, JET, and elsewhere. Antennas for FWCD draw heavily upon the experience gained in the design of ICRF heating systems with the additional requirement of launching a directional wave spectrum. Through collaborations with DIII-D, JET, and Tore Supra rapid progress is being made in the demonstration of the physics and technology of FWCD needed for TPX and ITER. (author).

31166 (JAERI-Conf–94-001, pp. 37-42) **ICRF heating antennas for Alcator C-Mod.** Takase, Y. (Massachusetts Inst. of Tech., Cambridge, MA (United States). Plasma Fusion Center); Golovato, S.N.; Porkolab, M. Japan Atomic Energy Research Inst., Tokyo (Japan). Aug 1994. (CONF-9311140–: IAEA meeting on radio-frequency launchers for plasma heating and current drive, Naka (Japan), 10-12 Nov 1993). In *Proceedings of the IAEA technical committee meeting on RF launchers for plasma heating and current drive.* 168p. Order Number DE95776546. Source: OSTI; NTIS; INIS.

Initial ICRF coupling studies were performed successfully on the Alcator C-Mod tokamak with all-metallic first wall, using a radially movable single current strap (monopole) antenna. The plasma loading is 10-30 times the vacuum loading, which is sufficient to inject 2 MW of RF power through one two-strap (dipole) antenna. The observed loading is consistent with predictions of full-wave calculations. Up to 1 MW of RF power (antenna power density of > or approx. 10 MW/m^2) has been injected into the C-Mod plasma with no increase in the fractional radiated power P_{rad}/P_{in}. Definite signs of both ion and electron heating were observed at power levels of 0.4 MW and higher (P_{RF}/P_{OH} > or approx. 0.3) in the D(H) minority heating regime. High power heating experiments with 4 MW of source power and two dipole antennas will begin in early 1994. (author).

31167 (JAERI-Conf–94-001, pp. 49-54) **New conceptual antenna with spiral structure and back Faraday shield for FWCD (fast wave current drive).** Saigusa, M. (Japan Atomic Energy Research Inst., Naka, Ibaraki (Japan). Naka Fusion Research Establishment); Moriyama, S.; Fujii, T.; Kimura, H. Japan Atomic Energy Research Inst., Tokyo (Japan). Aug 1994. (CONF-9311140–: IAEA meeting on radio-frequency launchers for plasma heating and current drive, Naka (Japan), 10-12 Nov 1993). In *Proceedings of the IAEA technical committee meeting on RF launchers for plasma heating and current drive.* 168p. Order Number DE95776546. Source: OSTI; NTIS; INIS.

A new conceptual antenna, which we call as a spiral antenna, is proposed as a traveling wave antenna for fast wave current drive in tokamaks. The features of the spiral antenna are a sharp N_z spectrum, easy impedance matching, N_z controllable and good coupling. A back Faraday shield is proposed for improving the cooling design of Faraday shield and better antenna-plasma coupling. A helical support which is a compact and wide band support is proposed as a kind of quarter wave length stub supports. The RF properties of the spiral antenna and the back Faraday shield have

been investigated by using mock-up antennas. The VSWR of spiral antenna is low at the wide frequency band from 15 MHz to 201 MHz. The back Faraday shield is effective for suppressing the RF toroidal electric field between adjacent currents straps. (author).

31168 (JAERI-Conf–94-001, pp. 55-58) **Combline antennas for launching traveling fast waves.** Moeller, C.P. (General Atomics, San Diego, CA (United States)); Gould, R.W.; Phelps, D.A.; Pinsker, R.I. Japan Atomic Energy Research Inst., Tokyo (Japan). Aug 1994. (CONF-9311140–: IAEA meeting on radio-frequency launchers for plasma heating and current drive, Naka (Japan), 10-12 Nov 1993). In *Proceedings of the IAEA technical committee meeting on RF launchers for plasma heating and current drive.* 168p. Order Number DE95776546. Source: OSTI; NTIS; INIS.

The combline structure shows promise for launching traveling fast magnetosonic waves with adjustable $n_{parallel}$ ($3 \leq n_{parallel} \leq 6$) for current drive. In this paper, the dispersion and damping properties of the combline antenna with and without a Faraday shield are given. The addition of a Faraday shield which eliminates the electrostatic coupling between current straps as well as between the straps and plasma offers the advantage of eliminating the need for the lumped capacitors which are otherwise required with this structure. The results of vacuum dispersion and damping measurements on a low power model antenna are also given. (author).

31169 (JAERI-Conf–94-001, pp. 59-64) **Concept of ceramics-free coaxial waveguide.** Arai, Hiroyuki (Yokohama National Univ. (Japan). Faculty of Engineering). Japan Atomic Energy Research Inst., Tokyo (Japan). Aug 1994. (CONF-9311140–: IAEA meeting on radio-frequency launchers for plasma heating and current drive, Naka (Japan), 10-12 Nov 1993). In *Proceedings of the IAEA technical committee meeting on RF launchers for plasma heating and current drive.* 168p. Order Number DE95776546. Source: OSTI; NTIS; INIS.

A critical key point of the ITER IC antenna is ceramics support of an internal conductor of a coaxial antenna feeder close to the plasma, because dielectric loss tangent of ceramics enhanced due to neutron irradiation limits significantly the antenna injection power. This paper presents a ceramics-free waveguide to overcome this problem by a T-shaped ridged waveguide with arms for the mechanical support. This ridged waveguide has a low cutoff frequency for its small cross section, which has been proposed for the conceptual design study of Fusion Experimental Reactor (FER) IC system and the high frequency supplementary IC system for ITER. This paper presents the concept of ceramics-free coaxial waveguide consisting of the coaxial-line and the ridged waveguide. This paper also presents the cutoff frequency and the electric field distribution of the ridged waveguide calculated by a finite element method and an approximate method. The power handling capability more than 3 MW is evaluated by using the transmission-line theory and the optimized antenna impedance considering the ITER plasma parameters. We verify this transmission-line model by one-tenth scale models experimentally. (author).

31170 (JAERI-Conf–94-001, pp. 65-68) **Development of ceramic-free antenna feeder.** Moriyama, S. (Japan Atomic Energy Research Inst., Tokyo (Japan)); Kimura, H.; Fujii, T.; Saigusa, M.; Arai, H. Japan Atomic Energy Research Inst., Tokyo (Japan). Aug 1994. (CONF-9311140–: IAEA meeting on radio-frequency launchers for plasma heating and current drive, Naka (Japan), 10-12 Nov 1993). In *Proceedings of the IAEA technical committee meeting on RF launchers for plasma heating and current drive.* 168p. Order Number DE95776546. Source: OSTI; NTIS; INIS.

We have proposed a ceramics-free antenna feeder line employing a ridged waveguide as a local support for IC antenna of next-generation tokamaks. One fourth mock-up model of the all metal waveguide designed for the ITER ICRF system is fabricated and electrical characteristics of the model including the coaxial line - waveguide converter are measured. Power reflection coefficient of the model including the coax-waveguide converter to the input coaxial line is estimated to be less than 15% below the cut-off frequency of 107 MHz and less than 3% above the cut-off frequency. It is found that this ceramics-free antenna support employing a ridged waveguide is quite available for IC antenna of next-generation tokamaks. (author).

31171 (JAERI-Conf–94-001, pp. 71-80) **Performance of LHCD (Lower Hybrid current drive) launchers on JT-60U.** Ikeda, Y. (Japan Atomic Energy Research Inst., Naka, Ibaraki (Japan). Naka Fusion Research Establishment); Seki, M.; Naito, O.; Ide, S.; Kondoh, T.; Maebara, S.; Ushigusa, K.; Imai, T. Japan Atomic Energy Research Inst., Tokyo (Japan). Aug 1994. (CONF-9311140–: IAEA meeting on radio-frequency launchers for plasma heating and current drive, Naka (Japan), 10-12 Nov 1993). In *Proceedings of the IAEA technical committee meeting on RF launchers for plasma heating and current drive.* 168p. Order Number DE95776546. Source: OSTI; NTIS; INIS.

A 48x4 multijunction launcher (CD-2) has been operated to drive plasma current up to 3.6 MA on JT-60U in addition to the 24x4 multijunction launcher (CD-1'). The CD-2 launcher employs the oversized waveguides to simplify the LH launching structure. A maximum power density at 25 MW/m^2 has been achieved on the CD-2 launcher after a few weeks operation without differential pumping system. The total injected power is up to ≈7 MW using the CD-2 and CD-1' launchers. A good coupling is obtained on the CD-2 launcher around 1-5% when the plasma-wall distance is around 100 mm. The current drive efficiency and profile controllability are well explained by the designed wave spectra without taking account of higher modes in the oversized waveguide. The maximum drive efficiency is 3.5×10^{19} A/m^{2}W. Thus, the availability of the simple LHCD launcher has demonstrated to perform high power LHCD experiments on JT-60U. (author).

31172 (JAERI-Conf–94-001, pp. 81-86) **Full-wave theory of a quasi-optical launching system for lower-hybrid waves.** Frezza, F. (Rome Univ. (Italy)); Gori, F.; Santarsiero, M.; Schettini, G.; Santini, F. Japan Atomic Energy Research Inst., Tokyo (Japan). Aug 1994. (CONF-9311140–: IAEA meeting on radio-frequency launchers for plasma heating and current drive, Naka (Japan), 10-12 Nov 1993). In *Proceedings of the IAEA technical committee meeting on RF launchers for plasma heating and current drive.* 168p. Order Number DE95776546. Source: OSTI; NTIS; INIS.

Numerical studies on the use of a quasi-optical grill to couple lower-hybrid waves to a plasma, for current drive in tokamaks, are currently under development. The study of the coupling has been carried out in a rigorous way, through the solution of the scattering from cylinders with parallel axes in the presence of a plane of discontinuity for electromagnetic constants. Here we restrict our attention to the case of a plasma with a step density profile, and report some results on launched spectra, coupled power, and directivity. (author).

31173 (JAERI-Conf–94-001, pp. 87-97) **Lower hybrid launcher on JET.** Soeldner, F.X. (Commission of the European Communities, Abingdon (United Kingdom). JET Joint Undertaking); Brusati, M.; Ekedahl, A. Japan Atomic Energy Research Inst., Tokyo (Japan). Aug 1994. (CONF-9311140–: IAEA meeting on radio-frequency launchers for plasma heating and current drive, Naka (Japan), 10-12 Nov 1993). In *Proceedings of the IAEA technical committee meeting on RF launchers for plasma heating and current drive.* 168p. Order Number DE95776546. Source: OSTI; NTIS; INIS.

Lower Hybrid current drive (LHCD) experiments were performed in JET in a first stage with one third of the final LHCD system. Good coupling with reflection coefficients as low as 1% and a power density of ≈4 kW/cm^2 on the plasma interface were obtained with the prototype launcher. The complete LHCD system with a total power of 12 MW (20 s) in the generator will start operation with the begin of JET divertor experiments in early 1994. The full launcher contains an array of 384 waveguides, built up from 48 multijunctions with internal power splitting. Three different LH wave spectra can be radiated simultaneously into the plasma, applying different phase settings to the three independent sections of the grill type antenna. test bed experiments have started on a new concept for a compact LH launcher, using a hyperguide as connection between an array of standard size waveguides and the plasma facing antenna structure which forms the slow wave LH spectrum. (author).

31174 (JAERI-Conf–94-001, pp. 125-133) **FWCD (fast wave current drive) and ECCD (electron cyclotron current drive) experiments on DIII-D.** Prater, R. (General Atomics, San Diego, CA

(United States)); Austin, M.; Baity, F.W. Japan Atomic Energy Research Inst., Tokyo (Japan). Aug 1994. (CONF-9311140--: IAEA meeting on radio-frequency launchers for plasma heating and current drive, Naka (Japan), 10-12 Nov 1993). In *Proceedings of the IAEA technical committee meeting on RF launchers for plasma heating and current drive.* 168p. Order Number DE95776546. Source: OSTI; NTIS; INIS.

Fast wave current drive and electron cyclotron current drive experiments have been performed on the DIII-D tokamak as part of the advanced tokamak program. The goal of this program is to develop techniques for controlling the profile of the current density in order to access regimes of improved confinement and stability. The experiments on fast wave current drive used a four strap antenna with 90deg phasing between straps. A decoupler was used to help maintain the phasing, and feedback control of the plasma position was used to keep the resistive loading constant. RF pickup loops demonstrate that the directivity of the antenna is as expected. Plasma currents up to 0.18 MA were driven by 1.5 MW of fast wave power. Electron cyclotron current drive experiments at 60 GHz have shown 0.1 MA of plasma current driven by 1 MW of power. New fast wave and electron cyclotron heating systems are in development for DIII-D, so that the goals of the advanced tokamak program can be carried out. (author).

31175 (JAERI-Conf--94-001, pp. 134-139) **ECH (electron cyclotron heating) experiments on WT-3 by a focusing launcher.** Terumichi, Y. (Kyoto Univ. (Japan). Dept. of Physics); Yoshimura, S.; Hanada, K.; Maekawa, T.; Nakamura, M.; Maehara, T.; Tabuchi, S.; Nakamura, K.; Iinuma, T. Japan Atomic Energy Research Inst., Tokyo (Japan). Aug 1994. (CONF-9311140--: IAEA meeting on radio-frequency launchers for plasma heating and current drive, Naka (Japan), 10-12 Nov 1993). In *Proceedings of the IAEA technical committee meeting on RF launchers for plasma heating and current drive.* 168p. Order Number DE95776546. Source: OSTI; NTIS; INIS.

1: Heat transport in Lower Hybrid Current Drive Plasma. A short electron cyclotron heating ($2\Omega_e$ECH) pulse can locally perturb the electron temperature. The temperature perturbation can be observed in the soft X-ray signal intensity. The radial thermal diffusion coefficient, χ_e, is estimated by propagation delay of the perturbed signal. It is found that there is a threshold of lower hybrid power above which χ_e falls to 1/2-1/3 times that of the target ohmic heating plasma. The improvement of χ_e is confirmed as effective $2\Omega_e$ECH that the central electron temperature rises up to 3 times that of the target plasma. 2: Stabilization of m=2 MHD Activity by $2\Omega_e$ECH. The stabilization or destabilization of the m/n=2/1 MHD activity by local $2\Omega_e$ECH was studied systematically in the WT-3 tokamak. The toroidal magnetic field was carefully scanned for signs of suppression or enhancement of the activity. It is found that the m/n=2/1 and 1/1 activities can be suppressed simultaneously when the electron cyclotron resonance in the equatorial plane is located in the narrow region near q=2 or 1 surface and the width of the region near q=1 depends on ECH power and the region spread inward q=1 surface with ECH power. (author).

31176 (JAERI-Conf--94-001, pp. 140-145) **Recent results with 140 GHz ECRH at the W7-AS stellarator.** Erckmann, V. (Max-Planck-Institut fuer Plasmaphysik, Garching (Germany)); Gasparino, U.; Maabberg, H. Japan Atomic Energy Research Inst., Tokyo (Japan). Aug 1994. (CONF-9311140--: IAEA meeting on radio-frequency launchers for plasma heating and current drive, Naka (Japan), 10-12 Nov 1993). In *Proceedings of the IAEA technical committee meeting on RF launchers for plasma heating and current drive.* 168p. Order Number DE95776546. Source: OSTI; NTIS; INIS.

A new 140 GHz ECRH system with 0.9 MW power at up to 0.4 s pulse duration (alternatively 0.5 MW, <1.1 s) is running at the W7-AS Stellarator. The Gaussian output mode of a Russian gyrotron is transmitted via an optical transmission line and launcher. A comparison of this advanced 140 GHz ECRH-system with the conventional 70 GHz system (0.8 MW, 3 s) is given with emphasis on technological aspects and investment-costs. Plasma experiments on combined heating with 70 GHz ECRH at moderate densities $\leq 6\ 10^{19}\ m^{-3}$ or with NBI at high densities $\leq 1.1\ 10^{20}\ m^{-3}$ are presented. (author).

31177 (JAERI-Conf--94-001, pp. 152-156) **ECH (electron cyclotron heating) launching system for LHD (large helical device) and CHS (compact helical system).** Kubo, S. (National Inst. for Fusion Science, Nagoya (Japan)); Ohkubo, K.; Idei, H.; Sato, M.; Takita, Y.; Kuroda, T. Japan Atomic Energy Research Inst., Tokyo (Japan). Aug 1994. (CONF-9311140--: IAEA meeting on radio-frequency launchers for plasma heating and current drive, Naka (Japan), 10-12 Nov 1993). In *Proceedings of the IAEA technical committee meeting on RF launchers for plasma heating and current drive.* 168p. Order Number DE95776546. Source: OSTI; NTIS; INIS.

The effectiveness of the mirror surface definition for the focusing mirrors using constant phase concept is demonstrated and actually applied for the new antenna system for CHS. Preliminary design of the ECH launcher for LHD is done based on the same idea. The minimum beam parameters are 15 mm in radial direction and 50 mm in toroidal direction under present allowed port space. (author).

31178 (JAERI-Research--95-041) **Development of built-in mode converter type gyrotron with 120GHz, 500kW-0.1sec.** Kasugai, Atsushi (Japan Atomic Energy Research Inst., Naka, Ibaraki (Japan). Naka Fusion Research Establishment); Tsuneoka, Masaki; Sakamoto, Keishi. Japan Atomic Energy Research Inst., Tokyo (Japan). Jun 1995. 23p. (In Japanese). Order Number DE96701322. Source: OSTI; NTIS; INIS.

High power gyrotron with the built-in quasi-optical mode converter was developed and it achieved the Gaussian beam output of 0.1sec, 460kW at 120GHz, which was converted from TE12,2 whispering gallery mode (WGM). Longer pulse operation of 0.215sec with the oscillation power of 250kW was made. Then, no evidence of RF breakdown at the output window and inside the tube was observed through the experiments for 0.1sec pulse duration. (author).

31179 (LA-UR--95-2459) **X-ray emission from colliding laser plasmas.** Wilke, M. (and others); Obst, A.W.; Winske, D. Los Alamos National Lab., NM (United States). [1995]. 15p. Sponsored by USDOE, Washington, DC (United States). DOE Contract W-7405-ENG-36. (CONF-950793--19: 40. annual meeting of the Society of Photo-Optical Instrumentation Engineers, San Diego, CA (United States), 9-14 Jul 1995). Order Number DE95016878. Source: OSTI; NTIS; GPO Dep.

Colliding Au, CD and Ti-Cr plasmas have been generated by illuminating two opposing foils each with a $\sim$ 100J, 0.5 nsec, 2ω Nd-glass laser beam from the Trident laser facility at Los Alamos. The plasmas are being used to study plasma interactions which span the parameter regime from interpenetrating to collisional stagnation. X-ray emission during the laser target interaction and the subsequent collision is used to diagnose the initial plasma conditions and the colliding plasma properties. X-ray instrumentation consists of a 100 ps gated x-ray pinhole imager, a time-integratcd bremsstrahlung x-ray spectrograph and a gated x-ray spectrograph used to record isoelectronic spectra from the Ti-Cr plasmas. The imager has obtained multi-frame images of the collision and therefore, a measure of the stagnation length which is a function of the ion charge state and density and a strong function of the electron temperature. Other instrumentation includes a Thomson scattering spectrometer with probe beam, neutron detectors used to monitor the CD coated foil collisions and an ion spectrometer. We will describe the current status of the experiments and current results with emphasis on the x-ray emission diagnostics. We will also briefly describe the modeling using Lasnex and ISIS, a particle-in-cell code with massless fluid electrons and inter particle (classical) collisions.

31180 (LA-UR--95-2819) **Plasma production from shock compression of condensed matter.** Tan, T.H.; Marsh, S.P. Sandia National Labs., Albuquerque, NM (United States). [1995]. 5p. Sponsored by USDOE, Washington, DC (United States). DOE Contract W-7405-ENG-36. (CONF-950846--50: American Physical Society biennial conference on shock compression of condensed matter, Seattle, WA (United States), 13-18 Aug 1995). Order Number DE96000007. Source: OSTI; NTIS; GPO Dep.

The experimental investigation of HE-driven, phased, cylindrical, SS liner implosion has yielded many interesting results. Plasma and radiation are found to be copiously produced. Plasmas with velocity up to 17 cm/μs are observed. The temperature in the expansion surface reaches 8 - 10 eV and stays hot for tens of

microseconds. The signatures of plasma interactions with the imploding wall and the glass port are clearly identified. Finally, a cluster of cooler but still self-luminous, high-density debris is observed to travel at 1.8 cm/μs. Additional experiments were carried out to study the plasma flow and reconvergence inside the liner cavity by inserting a diverting disk along the axis of implosion. Significant emission of vuv and soft x-rays is detected. All the experiments are guided by the calculations using the MESA 2D hydrocode and the results agree with many of the predictions.

31181 (LA-UR–95-2820) **Triton burnup study in JT-60U.** Nishitani, T. (Japan Atomic Energy Research Inst., Naka, Ibaraki (Japan). Naka Fusion Research Establishment); Hoek, M.; Isobe, M.; Tobita, K.; Kusama, Y.; Harano, H.; Wurden, G.A.; Chrien, R.E. Los Alamos National Lab., NM (United States). [1995]. 6p. Sponsored by USDOE, Washington, DC (United States). DOE Contract W-7405-ENG-36. (CONF-950704–11: 22. European conference on controlled fusion and plasma physics, Bournemouth (United Kingdom), 2-7 Jul 1995). Order Number DE96000166. Source: OSTI; NTIS; INIS; GPO Dep.

The behavior of 1 MeV tritons produced in the d(d,p)t reaction is important to predict the properties of D-T produced 3.5 MeV alphas because 1 MeV tritons and 3.5 MeV alphas have similar kinematic properties, such as Larmor radius and precession frequency. The confinement and slowing down of the fast tritons were investigated by measuring the 14 MeV and the 2.5 MeV neutron production rates. Here the time resolved triton burnup measurements have been performed using a new type 14 MeV neutron detector based on scintillating fibers, as part of a US-Japan tokamak collaboration. Loss of alpha particles due to toroidal ripple is one of the most important issues to be solved for a fusion reactor such as ITER. The authors investigated the toroidal ripple effect on the fast triton by analyzing the time history of the 14 MeV emission after NB turn-off.

31182 (LA-UR–95-2930) **DT neutron measurements and experience on TFTR.** Barnes, C.W. (Princeton Univ., NJ (United States). Plasma Physics Lab.); Duong, H.H.; Jassby, D.L. Los Alamos National Lab., NM (United States); Princeton Univ., NJ (United States). Plasma Physics Lab. [1995]. 10p. Sponsored by USDOE, Washington, DC (United States). DOE Contract W-7405-ENG-36 ; AC02-76CH03073. (CONF-950848–2: International workshop on diagnostics for ITER, Varenna (Italy), 28 Aug - 1 sep 1995). Order Number DE96000031. Source: OSTI; NTIS; INIS; GPO Dep.

Through semi-independent absolute calibrations of multiply redundant neutron detector systems, the Tokamak Fusion Test Reactor (TFIR) has achieved $\pm$7% (one-sigma) accuracy in its fusion power measurements. This has required careful attention to the linearity of detectors up to the present highest fusion power levels achieved on TFTR of over 10 MW. The extended duration of the DT program on TFTR has also tested the stability of the detector systems. These issues of calibration, linearity, and stability are reviewed for the TFTR experience and how it can be applied to plans for ITER.

31183 (LA-UR–95-2945) **Numerical simulation of dusty plasmas.** Winske, D. Los Alamos National Lab., NM (United States). [1995]. 20p. Sponsored by USDOE, Washington, DC (United States). DOE Contract W-7405-ENG-36. (CONF-9503191–1: 6. workshop on dusty plasmas, San Diego, CA (United States), Mar 1995). Order Number DE96000043. Source: OSTI; NTIS; GPO Dep.

The numerical simulation of physical processes in dusty plasmas is reviewed, with emphasis on recent results and unresolved issues. Three areas of research are discussed: grain charging, weak dust-plasma interactions, and strong dust-plasma interactions. For each area, we review the basic concepts that are tested by simulations, present some appropriate examples, and examine numerical issues associated with extending present work.

31184 (LA-UR–95-2993) **A rad-hard, steady state, digital imaging bolometer system for ITER.** Wurden, G.A. Los Alamos National Lab., NM (United States). [1995]. 5p. Sponsored by USDOE, Washington, DC (United States). DOE Contract W-7405-ENG-36. (CONF-950848–1: International workshop on diagnostics for ITER, Varenna (Italy), 28 Aug - 1 sep 1995). Order Number DE96000028. Source: OSTI; NTIS; INIS; GPO Dep.

The concept and design of a new type of bolometer system which can function with excellent spatial resolution and good time resolution in the next generation of long-pulse (or steady-state), harsh-neutron environment fusion plasmas, is outlined. It uses a cooled pinhole camera design, employing a robust, passive, segmented radiation absorber, cooled from the back-side. Infrared emission from the absorber's front surface is relayed by metal mirror optics to a shielded, high-resolution IR video camera with $\pm$ 0.01 C temperature resolution. It can make thousands of simultaneous "pixel" measurements at up to 50–60 Hz, without any signal wires through the vacuum interface.

31185 (LA-UR–95-3106) **Comparing calculated and measured x-ray images.** Matuska, W.; Benage, J.; Idzorek, G.; Lebeda, C.; Peterson, D. Los Alamos National Lab., NM (United States). [1995]. 9p. Sponsored by USDOE, Washington, DC (United States). DOE Contract W-7405-ENG-36. (CONF-950750–36: 10. Institute of Electrical and Electronics Engineers (IEEE) pulsed power conference, Albuquerque, NM (United States), 10-13 Jul 1995). Order Number DE96000045. Source: OSTI; NTIS; INIS; GPO Dep.

In recent years 2-dimensional radiation-magneto-hydrodynamic (RMHD) calculations have done quite well in matching some important observed parameters of a z-pinch implosion. As the authors gain experience, they field more complex experiments to compare with calculations. Here they discuss both time dependent and time integrated x-ray imaging on Pegasus. Images, using similar filters, are calculated and compared with the data. They also apply some image enhancement to the data.

31186 (LRP–522/95) **Visualization of powder trapping in rf silane plasmas by 2-D polarization-sensitive laser scattering.** Dorier, J.L. (Ecole Polytechnique Federale, Lausanne (Switzerland). Centre de Recherche en Physique des Plasma (CRPP)); Hollenstein, C.; Howling, A.A.; Schwarzenbach, W.; Merad, A.; Boeuf, J.P. Ecole Polytechnique Federale, Lausanne (Switzerland). Centre de Recherche en Physique des Plasma (CRPP). Jul 1995. 5p. Order Number DE96602359. Source: OSTI; NTIS; INIS.

Powder studies in plasmas are motivated by the need to reduce contamination during plasma processing. Understanding particle dynamics requires comparison of spatially-resolved measurements with 2-D simulations. In this work, a cross-section of a capacitive discharge is illuminated with a polarized expanded laser beam and global scattered light is recorded by a CCD camera. For steady-state conditions with many particles, spatial size segregation is demonstrated by fringes which reverse with the light polarization. Plasma equipotentials near the potential maximum are visualized using the scattered intensity from a small amount of particles trapped in an argon plasma. Good agreement is found with 2-D fluid simulations. (author) 2 figs., 9 refs.

31187 (LRP–523/95) **Measurement of the velocity spread of the electron beam of a quasi-optical gyrotron.** Soumagne, G. (Ecole Polytechnique Federale, Lausanne (Switzerland). Centre de Recherche en Physique des Plasma (CRPP)). Ecole Polytechnique Federale, Lausanne (Switzerland). Centre de Recherche en Physique des Plasma (CRPP). Jul 1995. 171p. (In French). Order Number DE96602360. Source: OSTI; NTIS; INIS.

The efficiency of the gyrotron interactions between the weakly relativistic electron beam and an electromagnetic wave depends on the electron beam parameters. Measured efficiencies of the interaction are smaller than predicted by theory. Therefore, experimental methods have to be developed in order to obtain the necessary information concerning the velocity distribution function of the electron beam. In this thesis, Thomson scattering and electron cyclotron emission have been studied as new in situ diagnostics of the laminar electron beam in a 100 GHz quasi-optical gyrotron. Whereas Thomson scattering can in principle be used to measure the mean velocity of the electron beam, its application was abandoned mainly due to technical constraints of the gyrotron. On the other hand, the Doppler shift and Doppler broadening of the electron cyclotron emission were measured in the interaction region of the quasi-optical gyrotron by observing the spontaneous emission at an angle of 15° with respect to the external magnetic

field. At the given angle of 15° the spectra are dominated by the parallel velocity distribution function, whereas the influence of the spread in the relativistic factor, γ, can be neglected for relative spreads, $\delta\gamma$, smaller than 2%. In order to suppress the stimulated emission of the electrons, the gyrotron was operated without resonator. Measurements were performed with a heterodyne detection system and a spectrometer consisting of two channels with center frequencies at 8.00 and 8.50 GHz ($\pm$0.05 GHz). The spectra were measured between 130.0 and 148.5 GHz by stepping the local oscillator by 1.0 GHz from shot to shot. The half-width of the measured spectra is typically 5-6 GHz. Since the frequency of the local oscillator is not scanned during a shot, time resolved spectra are obtained. (author) figs., tabs., 125 refs.

31188 (NIFS-DATA–25) **Roles of atomic and molecular processes in fusion plasma researches. From the cradle (plasma production) to the grave (after-burning).** Tawara, Hiro. National Inst. for Fusion Science, Nagoya (Japan). May 1995. 54p. Order Number DE96701328. Source: OSTI; NTIS; INIS.

This short lecture given at RIKEN Winter School on Atomic and Molecular Processes in Tsunan, Niigata, has described some crucial roles of atomic and molecular (AM) physics in magnetic fusion plasma research. Particular importance has been stressed of collision processes involving species in the excited states in fusion plasmas, especially in divertor and edge plasmas. (author).

31189 (NUREG/CP–0142-Vol.1, pp. 49-75) **Prospects for bubble fusion.** Nigmatulin, R.I. (Tyumen Institute of Mechanics of Multiphase Systems (TIMMS), Marx (Russian Federation)); Lahey, R.T. Jr. Nuclear Regulatory Commission, Washington, DC (United States). Div. of Systems Technology; American Nuclear Society, La Grange Park, IL (United States); American Inst. of Chemical Engineers, New York, NY (United States); American Society of Mechanical Engineers, New York, NY (United States); Canadian Nuclear Society, Toronto, ON (Canada); Japan Society of Multiphase Flow, Kyoto (Japan). Sep 1995. (CONF-950904–Vol.1: 7. international meeting on nuclear reactor thermal hydraulics, Saratoga, NY (United States), 10-15 Sep 1995). In *Proceedings of the 7th International Meeting on Nuclear Reactor Thermal-Hydraulics NURETH-7. Volume 1, Sessions 1-5.* 862p. Source: OSTI; NTIS; INIS; GPO.

In this paper a new method for the realization of fusion energy is presented. This method is based on the superhigh compression of a gas bubble (deuterium or deuterium/thritium) in heavy water or another liquid. The superhigh compression of a gas bubble in a liquid is achieved through forced non-linear, non-periodic resonance oscillations using moderate amplitudes of forcing pressure. The key feature of this new method is a coordination of the forced liquid pressure change with the change of bubble volume. The corresponding regime of the bubble oscillation has been called "basketball dribbling (BD) regime". The analytical solution describing this process for spherically symmetric bubble oscillations, neglecting dissipation and compressibility of the liquid, has been obtained. This solution shown no limitation on the supercompression of the bubble and the corresponding maximum temperature. The various dissipation mechanisms, including viscous, conductive and radiation heat losses have been considered. It is shown that in spite of these losses it is possible to achieve very high gas bubble temperatures. This because the time duration of the gas bubble supercompression becomes very short when increasing the intensity of compression, thus limiting the energy losses. Significantly, the calculated maximum gas temperatures have shown that nuclear fusion may be possible. First estimations of the affect of liquid compressibility have been made to determine possible limitations on gas bubble compression. The next step will be to investigate the role of interfacial instability and breaking down of the bubble, shock wave phenomena around and in the bubble and mutual diffusion of the gas and the liquid.

31190 (ORNL/TM–13074) **A Landau fluid model for dissipative trapped electron modes.** Hedrick, C.L.; Leboeuf, J.N.; Sidikman, K.L. Oak Ridge National Lab., TN (United States). Sep 1995. 50p. Sponsored by USDOE, Washington, DC (United States). DOE Contract AC05-84OR21400. Order Number DE96001018. Source: OSTI; NTIS; INIS; GPO Dep.

A Landau fluid model for dissipative trapped electron modes is developed which focuses on an improved description of the ion dynamics. The model is simple enough to allow nonlinear calculations with many harmonics for the times necessary to reach saturation. The model is motivated by a discussion that starts with the gyrokinetic equation and emphasizes the importance of simultaneously including particular features of magnetic drift resonance, shear, and Landau effects. To ensure that these features are simultaneously incorporated in a Landau fluid model with only two evolution equations, a new approach to determining the closure coefficients is employed. The effect of this technique is to reduce the matching of fluid and kinetic responses to a single variable, rather than two, and to allow focusing on essential features of the fluctuations in question, rather than features that are only important for other types of fluctuations. Radially resolved nonlinear calculations of this model, advanced in time to reach saturation, are presented to partially illustrate its intended use. These calculations have a large number of poloidal and toroidal harmonics to represent the nonlinear dynamics in a converged steady state which includes cascading of energy to both short and long wavelengths.

31191 (PPPL-CFP–3350) **Physics research needs for ITER.** Sauthoff, N.R. Princeton Univ., NJ (United States). Plasma Physics Lab. [1995]. 6p. Sponsored by USDOE, Washington, DC (United States). DOE Contract AC02-76CH03073. (CONF-9506242–2: International workshop on advanced fusion science research, Taejeon (Korea, Republic of), 21-24 Jun 1995). Order Number DE95014766. Source: OSTI; NTIS; INIS; GPO Dep.

Design of ITER entails the application of physics design tools that have been validated against the world-wide data base of fusion research. In many cases, these tools do not yet exist and must be developed as part of the ITER physics program. ITER's considerable increases in power and size demand significant extrapolations from the current data base; in several cases, new physical effects are projected to dominate the behavior of the ITER plasma. This paper focuses on those design tools and data that have been identified by the ITER team and are not yet available; these needs serve as the basis for the ITER Physics Research Needs, which have been developed jointly by the ITER Physics Expert Groups and the ITER design team. Development of the tools and the supporting data base is an on-going activity that constitutes a significant opportunity for contributions to the ITER program by fusion research programs world-wide.

31192 (UCRL-ID–121379) **Milestone report: Status report on high βp experiments at high plasma current.** Casper, T.A.; James, R.A.; Rice, B.W.; Stallard, B.W. Lawrence Livermore National Lab., CA (United States). Jul 1995. 15p. Sponsored by USDOE, Washington, DC (United States). DOE Contract W-7405-ENG-48. Order Number DE96001008. Source: OSTI; NTIS; INIS; GPO Dep.

This report summarizes LLNL's involvement in recent high β_p experiments on the DIII-D tokamak at General Atomics. These experiments were done in collaboration with several members of the DIII-D physics staff from GA and from other collaborating institutions and could not have succeeded without this joint effort. In this report, the authors summary a specific, limited set of experiments to extend high β_p operation with enhanced core confinement to higher plasma currents. The interest in these experiments stems from the non-inductive current drive requirement for steady-state advanced tokamak regimes which can most reasonably be met by operation with a high bootstrap current fraction.

31193 (UCRL-ID–121728) **Comments on the kinetic dynamo.** Fowler, T.K. Lawrence Livermore National Lab., CA (United States). 24 Aug 1995. 15p. Sponsored by USDOE, Washington, DC (United States). DOE Contract W-7405-ENG-48. Order Number DE96001025. Source: OSTI; NTIS; INIS; GPO Dep.

It is conjectured that transport by parallel mass flow in a braided magnetic field, rather than hyper-resistivity, drives the dynamo effect after stochasticity is established. In this paper the authors do not attempt a rigorous proof of this conjecture, which requires showing that braiding introduces correlations analogous to those giving rise to the neoclassical bootstrap current. The authors do offer plausible arguments for the conjecture and show that it leads to interesting consequences if true. Namely, magnetic fluctuations

would then scale with the magnetic Reynolds number S like $\tilde{B}/B \sim S^{-1/2}$ and the Rechester-Rosenbluth thermal diffusivity like $\chi e \propto S^{-1}$. This scaling would explain the highest temperatures obtained in the CTX spheromak. It also suggests that a fully-bootstrapped current drive experiment could be carried out on-the DIII-D tokamak.

31194 (UCRL-ID–121826) **Rayleigh-Taylor instability experiments in a cylindrically convergent geometry.** Goodwin, B.; Weir, S. Lawrence Livermore National Lab., CA (United States). 25 Aug 1995. 9p. Sponsored by USDOE, Washington, DC (United States). DOE Contract W-7405-ENG-48. Order Number DE96000373. Source: OSTI; NTIS; GPO Dep.

Due to the sensitivity of Rayleigh-Taylor instabilities to initial conditions and due to the difficulty of forming well controlled cylindrical or spherical fluid interfaces, Rayleigh-Taylor experiments are often performed with simple, planar interfaces. Rayleigh-Taylor instability phenomena of practical interest, however, (e.g., underwater explosions, supernova core collapses, and inertial confinement fusion capsule implosions) are typically associated with cylindrical or spherical interfaces in which convergent flow effects have an important influence on the dynamics of instability growth. Recently, Meshkov et.al. have developed a novel technique for studying Rayleigh-Taylor instability growth in a cylindrically convergent geometry. Their experiments utilized low-strength gelatin rings which are imploded by a detonating gas mixture of oxygen and acetylene. Since the gelatin itself has sufficient strength to resist significant deformation by gravity, no membranes are needed to define the ring shape. This experimental technique is attractive because it offers a high degree of control over the interfacial geometry and over the material's strength and rigidity, which can be varied by adjusting the gelatin concentration. Finally, since both the gelatin and the explosive product gases are transparent, optical diagnostics can be used.

31195 (UCRL-JC–118834) **Measurements of large scale-length plasmas produced from gas-filled targets.** Back, C.A. (and others); Berger, R.L.; Estabrook, K. Lawrence Livermore National Lab., CA (United States). 30 Jun 1995. 20p. Sponsored by USDOE, Washington, DC (United States). DOE Contract W-7405-ENG-48. (CONF-9410314–4: 6. international workshop on radiative properties of hot dense matter, Sarasota, FL (United States), 31 Oct - 4 nov 1994). Order Number DE95015983. Source: OSTI; NTIS; INIS; GPO Dep.

Apart from their intrinsic interest, plasma physics processes are important because they affect the coupling of the laser energy into laser-irradiated targets. Recently, new gas-filled targets have been developed to create large mm-size plasmas for the study of stimulated Brillouin scattering (SBS) and stimulated Raman scattering (SRS). We present x-ray images and x-ray spectra to characterize these targets, which show that the plasmas are homogeneous, have electron densities of $\sim 10^{21}$ cm^{-3}, and attain electron temperatures of ~3 keV. We also present SBS measurements to demonstrate how systematic studies of physical phenomena can be performed using these targets.

31196 (UCRL-JC–119068) **Absorption of laser light in overdense plasmas by sheath inverse bremsstrahlung.** Yang, T.Y.B.; Kruer, W.L.; More, R.M. Lawrence Livermore National Lab., CA (United States). Nov 1994. 21p. Sponsored by USDOE, Washington, DC (United States). DOE Contract W-7405-ENG-48. (CONF-941101–13: Meeting of the Division of Plasma Physics of the American Physical Society, Minneapolis, MN (United States), 7-11 Nov 1994). Order Number DE95017273. Source: OSTI; NTIS; GPO Dep.

The original sheath inverse bremsstrahlung model [P. J. Catto and R. M. More, 1977] is modified by including the vxB term in the equation of motion. It is shown that the present results axe significantly different from those derived without the vxB term. The vxB term is also important in interpreting the absorption mechanism. If the vxB term were neglected, the absorption of the light would be incorrectly interpreted as an increase in the transverse electron temperature. This would violate the conservation of the transverse components of the canonical momentum, in the case of a normally incident laser light. It is also shown that both the sheath inverse bremsstrahlung and the anomalous skin effect are limiting cases of the same collisionless absorption mechanism. Finally, results from PIC plasma simulations are compared with the absorption coefficient calculated from the linear theory.

31197 (UCRL-JC–119326) **X-ray framing cameras for > 5 keV imaging.** Landen, O.L.; Bell, P.M.; Costa, R.; Kalantar, D.H.; Bradley, D.K. Lawrence Livermore National Lab., CA (United States). 20 Jul 1995. 10p. Sponsored by USDOE, Washington, DC (United States). DOE Contract W-7405-ENG-48. (CONF-950793–44: 40. annual meeting of the Society of Photo-Optical Instrumentation Engineers, San Diego, CA (United States), 9-14 Jul 1995). Order Number DE95017877. Source: OSTI; NTIS; INIS; GPO Dep.

Recent and proposed improvements in spatial resolution, temporal resolution, contrast, and detection efficiency for x-ray framing cameras are discussed in light of present and future laser-plasma diagnostic needs. In particular, improvements in image contrast above hard x-ray background levels is demonstrated by using high aspect ratio tapered pinholes.

31198 (UCRL-JC–120413) **Experiments and modeling with a large-area inductively coupled plasma (ICP) source.** Benjamin, R.D.; DiPeso, G.; Egan, P.O.; Parker, G.J.; Richardson, R.A.; Vitello, P. Lawrence Livermore National Lab., CA (United States). Jun 1995. 10p. Sponsored by USDOE, Washington, DC (United States). DOE Contract W-7405-ENG-48. (CONF-9505270–1: 3. international workshop on advanced plasma tools, San Jose, CA (United States), 3-4 May 1995). Order Number DE95017045. Source: OSTI; NTIS; GPO Dep.

We describe initial experiments with a large (30 in.) plasma source chamber to explore the problems associated with large-area Inductively coupled plasma (ICP) sources to produce high density plasmas useful for processing 400 mm semiconductor wafers. Our experiments typically use a 25 in. diameter planar ICP coil driven at 13.56 MHz. Plasma and system data are taken in Ar and N_2 over the pressure range 3–50 mtorr. R.F. Inductive power was run up to 2000W, but typically data were taken over the range 100–1000W. Diagnostics Include optical emission spectroscopy, Langmuir probes, and B-dot probes as well as electrical circuit measurements. The B-dot and E-M measurements are compared with models based on commercial E-M codes. Initial indications are that uniform plasmas suitable for 400 mm processing are attainable. We present a comparison between computer modeling and experimental results for this source. Computer simulations using the fluid code INDUCT94 are used to explain variations In the plasma density profile measurements as a function of Inductive power, gas pressure and gas composition. Both Argon and Nitrogen discharges are modeled. INDUCT94 solves the 2D time-dependent fluid equations for electrons, ions and neutrals Including effects of both Inductive and capacitive coupling. Detailed volume and surface chemistry reactions are treated. We discuss the effects of pressure and power on plasma uniformity.

31199 (UCRL-JC–121197) **Efficient broadband third harmonic frequency conversion via angular dispersion.** Pennington, D.M.; Henesian, M.A.; Milam, D.; Eimerl, D. Lawrence Livermore National Lab., CA (United States). 18 Jul 1995. 10p. Sponsored by USDOE, Washington, DC (United States). DOE Contract W-7405-ENG-48. (CONF-9505264–12: 1. annual solid-state lasers for application to inertial confinement fusion meeting, Monterey, CA (United States), 30 May - 2 jun 1995). Order Number DE96000343. Source: OSTI; NTIS; INIS; GPO Dep.

In this paper we present experimental measurements and theoretical modeling of third harmonic (3ω) conversion efficiency with optical bandwidth. Third harmonic conversion efficiency drops precipitously as the input bandwidth significantly exceeds the phase matching limitations of the conversion crystals. For Type I/Type II frequency tripling, conversion efficiency be-gins to decrease for bandwidths greater than ~60 GHz. However, conversion efficiency corresponding to monochromatic phase-matched beams can be recovered provided that the instantaneous Propagation vectors are phase matched at all times. This is achieved by imposing angular spectral dispersion (ASD) on the input beam via a diffraction grating, with a dispersion such that the phase mismatch for each frequency is zero. Experiments were performed on the Optical

Sciences Laser (OSL), a 1–100 J class laser at LLNL. These experiments used a 200 GHz bandwidth source produced by a multipassed electro-optic phase modulator. The spectrum produced was composed of discrete frequency components spaced at 3 GHz intervals. Angular dispersion was incorporated by the addition of a 1200 gr/mm diffraction grating oriented at the Littrow angle, and capable of rotation about the beam direction. Experiments were performed with a pulse length of 1-ns and a 1ω input intensity of $\sim$ 4 GW/cm^2 for near optimal dispersion for phase matching, 5.2 μrad/GHz, with 0.1, 60, and 155 GHz bandwidth, as well as for partial dispersion compensation, 1.66 μrad/GHz, with 155 GHz and 0.1 GHz bandwidth. The direction of dispersion was varied incrementally 360° about the beam diameter. The addition of the grating to the beamline reduced the narrowband conversion efficiency by approximately 10%.

31200 (UCRL-JC–121200) **X-ray laser interferometry for probing high-density plasmas.** Wan, A.S. (and others); Da Silva, L.B.; Barbee, T.W. Jr. Lawrence Livermore National Lab., CA (United States). Jun 1995. 11p. Sponsored by USDOE, Washington, DC (United States). DOE Contract W-7405-ENG-48. (CONF-950793–37: 40. annual meeting of the Society of Photo-Optical Instrumentation Engineers, San Diego, CA (United States), 9-14 Jul 1995). Order Number DE95017295. Source: OSTI; NTIS; GPO Dep.

Collisionally pumped soft x-ray lasers now operate over a wavelength range extending from 4-40 nm. With the recent advances in the development of multilayer mirrors and beamsplitters in the soft x-ray regime, the authors can utilize the unique properties of x-ray lasers to study large, rapidly evolving laser-driven plasmas with high electron densities. Using a neon-like yttrium x-ray laser which operates at a wavelength of 15.5 nm, they have performed a series of x-ray laser interferometry experiments to characterize plasmas relevant to inertial confinement fusion. In this paper the authors describe experiments using a soft x-ray laser interferometer, operated in the Mach-Zehnder configuration, to study CH plasmas and exploding foil targets commonly used for x-ray laser targets. The two-dimensional density profiles obtained from the interferograms allow the authors to validate and benchmark their numerical models used to study the physics of laser-plasma interactions.

31201 (UCRL-JC–121582) **X-ray spectroscopy and imaging of a plasma collision.** Chenais-Popovics, C. (Ecole Polytechnique - 91, Palaiseau (France). Lab. pour l'Utilisation des Lasers Intenses); Rancu, O.; Renaudin, P. Lawrence Livermore National Lab., CA (United States). 14 Jul 1995. 8p. Sponsored by USDOE, Washington, DC (United States);European Economic Community, Brussels (Belgium). DOE Contract W-7405-ENG-48. (CONF-950793–29: 40. annual meeting of the Society of Photo-Optical Instrumentation Engineers, San Diego, CA (United States), 9-14 Jul 1995). Order Number DE95016631. Source: OSTI; NTIS; INIS; GPO Dep.

The collision of laser-produced plasmas has been diagnosed by x-ray spectroscopy and imaging. The two colliding plasmas are produced on Al thin foils at a distance of 200 to 900 μm irradiated at λ = 0.53 μm with laser intensities of 3 x 10^{13} to 6 x 10^{13} W/cm^2. Interpenetration of the plasmas was visualized by replacing one of the foils material by magnesium. The main diagnostics viewing the inter-target space were time-resolved monochromatic imaging of the $1s^2$ 1s3p aluminum line (HeB at λ – 6.635 Å). Doppler broadening measurement with a vertical Johann very high resolution spectrograph in the range 6.5–6.7Å, space-resolved high resolution spectra of the dielectronic satellites of the 1s-2p 1 yman, space-resolved spectra with a flat-crystal spectrograph in the range 5–7 Å and in the range of 43–48 Å obtained with a new OHM crystal spectrograph and a pinhole camera. A multifluid eulerian monodimensional hydrodynamic code coupled with a radiative-atomic package provided simulations of the experiments. Hydrodynamic 2D simulations calculating the lateral expansion of the plasma enabled a reliable treatment of reabsorption along the line of sight of the spectrographs. The size the time duration of the collision, the plasma parameters (Te,Ti and ne) in the collision region and interpenetration were measured. The hydrocode simulations give a good understanding of the behavior of the collision in function of intertarget distance and laser intensity.

31202 (UCRL-JC–121589) **Characterization and modeling of soft x-ray lasers.** Wan, A.S.; Cauble, R.; Celliers, P.; DaSilva, L.B.; Libby, S.B.; London, R.A.; Nilsen, J.; Moreno, J.C.; Weber, F. Lawrence Livermore National Lab., CA (United States). [1995]. 4p. Sponsored by USDOE, Washington, DC (United States). DOE Contract W-7405-ENG-48. (CONF-9510193–4: LEOS '95: Institute of Electrical and Electronics Engineers Lasers and Electro-Optics Society annual meeting, San Francisco, CA (United States), 30 Oct - 2 nov 1995). Order Number DE96000697. Source: OSTI; NTIS; INIS; GPO Dep.

This paper describes our theoretical, numerical, and experimental development of short-pulse-duration, high brightness, and enhanced coherence x-ray lasers (XRLs) as sources suitable for applications as imaging diagnostics for laser plasmas.

31203 (UCRL-JC–121629) **Development of XUV-interferometry (155 Å) using a soft x-ray laser.** Da Silva, L.B. (and others); Barbee, T.W.; Cauble, R. Lawrence Livermore National Lab., CA (United States). 1 Aug 1995. 20p. Sponsored by USDOE, Washington, DC (United States). DOE Contract W-7405-ENG-48. (CONF-950793–47: 40. annual meeting of the Society of Photo-Optical Instrumentation Engineers, San Diego, CA (United States), 9-14 Jul 1995). Order Number DE96000702. Source: OSTI; NTIS; INIS; GPO Dep.

Over the past several years the authors have developed a variety of techniques for probing plasmas with x-ray lasers. These have included direct high resolution plasma imaging to quantify laser produced plasma uniformities and moire deflectometry to measure electron density profiles in one-dimension. Although these techniques have been valuable, a need existed for direct two dimensional measurements of electron densities in large high density plasmas. For this reason the authors have worked on developing a xuv interferometer compatible with the harsh environment of laser produced plasmas. This paper describes the design and presents some results showing excellent fringe visibility using the neon-like yttrium x-ray laser operating at 155 Å. The coherence properties of this x-ray laser source were measured using interferometry and are also discussed.

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Refer also to citation(s) 29528, 29831, 29993, 29999, 30000, 30001, 30002, 30003, 30004, 30006, 30008, 30009, 30010, 30011, 30015, 30016, 30019, 30023, 30024, 30046, 30047, 30052, 30095, 30096, 30098, 30100, 30156, 30157, 30158, 30159, 30160, 30186, 30386, 30390, 30391, 30393, 30394, 30604, 30605, 31096, 31097, 31098, 31191, 31380, 31387

31204 (CONF-9505105–17) **Measurement of rf voltages on the plasma-touching surfaces of ICRF antennas.** Hoffman, D.J.; Baity, F.W.; Bell, G.L.; Bigelow, T.S.; Caughman, J.B.O.; Goulding, R.H.; Haste, G.R.; Ryan, P.M.; Zhang, H. Oak Ridge National Lab., TN (United States). [1995]. 4p. Sponsored by USDOE, Washington, DC (United States). DOE Contract AC05-84OR21400. From 11. topical conference on radio frequency in plasmas; Palm Springs, CA (United States); 17-19 May 1995. Order Number DE95017400. Source: OSTI; NTIS; INIS; GPO Dep.

Measurements of the rf voltages on Faraday shields and protection bumpers have been made for several loop antennas, including the mock-up antenna and Al for JET, the original antenna for Tore Supra, the present ASDEX-U antenna, and the folded waveguide. The loop antennas show voltages that scale to $\approx$12 kV for a maximum input voltage of 30 kV with 0/0 phasing. The voltages are dramatically reduced for 0/π phasing. These voltages are significant in that they can substantially increase the rf sheath potential beyond the levels associated with the simple electromagnetic field linkage from the current straps that results in plasma heating. In this paper, we investigate and measure the source of these voltages, their scaling with antenna impedance, and the differences between the loop arrays.

31205 (CONF-9505254–5) **ORNL stellarator divertor studies.** Rome, J.A.; Lee, D.K.; England, A.C.; Lyon, J.F. Oak Ridge National Lab., TN (United States). [1995]. 5p. Sponsored by

USDOE, Washington, DC (United States). DOE Contract AC05-84OR21400. From International stellarator workshop; Madrid (Spain); 22-26 May 1995. Order Number DE95017383. Source: OSTI; NTIS; INIS; GPO Dep.

Oak Ridge National Laboratory (ORNL) is studying various aspects of divertors in different stellarators. We are looking at a local island divertor (LID) on the CHS helical system, and potential designs of divertors that use islands for modular stellarators such as W7-AS and the modular helias-like heliac MHH chosen for the US Stellarator Power Plant Study. Although the helical CHS configuration is quite different from the modular W 7-AS configuration both rely on the island structure outside the last closed flux surface (LCFS) to aid in funneling escaping plasma flux and to protect the leading edges of the divertor plates. However, the way that the islands are used is quite different.

31206 (CONF-9505284–1) **Integrated design and analysis of rf heating and current drive systems.** Ryan, P.M. (and others); Carter, M.D.; Goulding, R.H. Oak Ridge National Lab., TN (United States). [1995]. 11p. Sponsored by USDOE, Washington, DC (United States). DOE Contract AC05-84OR21400. From 11. topical conference on radio frequency power in plasmas; Palm Springs, CA (United States); 17-19 May 1995. Order Number DE95017416. Source: OSTI; NTIS; INIS; GPO Dep.

The design, analysis, and performance evaluation of rf power systems ultimately requires accurate modeling of a chain of subsystems starting with the rf transmitter and ending with the power absorption in the plasma. A collection of computer codes is used at ORNL to calculate the plasma loading and wave spectrum for a three-dimensional rf antenna, the transmission/reflection properties of the Faraday shield and its effect on the electrical characteristics and phase velocity of the antenna, the internal coupling among antenna array components and the incorporation of the antenna array into a transmission line model of the phase control, tuning, matching, and power distribution system. Some codes and techniques are more suited for the rapid evaluation of system design progressions, while others are more applicable to the detailed analysis of final designs or existing hardware. The interaction of codes and the accuracy of calculations will be illustrated by the process of determining the plasma loading as a function of phasing and density profiles for the TFTR ICRH antennas and comparing the results to measurements. An example of modeling a complex antenna geometry will be the comparison of calculations with the measured electrical response of a four-strap mockup of the JET A2 antenna array which was loaned to ORNL by the JET ICRH team.

31207 (CONF-9505284–3) **Commissioning of the long-pulse fast wave current drive antennas for DIII-D.** Baity, F.W. (Oak Ridge National Lab., TN (United States)); Barber, G.C.; Goulding, R.H.; Hoffman, D.J.; DeGrassie, J.S.; Pinsker, R.I.; Petty, C.C.; Cary, W. Oak Ridge National Lab., TN (United States); General Atomics, San Diego, CA (United States). [1995]. 4p. Sponsored by USDOE, Washington, DC (United States). DOE Contract AC05-84OR21400 ; AC03-89ER51114. From 11. topical conference on radio frequency power in plasmas; Palm Springs, CA (United States); 17-19 May 1995. Order Number DE95017414. Source: OSTI; NTIS; INIS; GPO Dep.

Two new four-element fast wave current drive antennas have been installed on DIII-D. These antennas are designed for 10-s pulses at 2 MW each in the frequency range of 30 to 120 MHz. Each element comprises two poloidal segments fed in parallel in order to optimize plasma coupling at the upper end of the frequency range. The antennas are mounted on opposite sides of the vacuum vessel, in ports designated 0° and 180° after their toroidal angle. Each antenna array is fed by a single transmitter. The power is first split two ways by means of a 3-dB hybrid coupler, then each of these lines feeds a resonant loop connecting a pair of array elements. The power transfer during asymmetric phasing is shunted between resonant loops by a decoupler. The resonant loops are fitted with line stretchers so that multiple frequencies of operation are possible without reconfiguring the transmission line. Commissioning of these antennas has been underway since June 1994. Several deficiencies in the transmission line system were uncovered during initial vacuum conditioning, including problems with the transmission line insulators and with the drive rods for the variable elements. The former was solved by replacing the original alumina insulators, and the latter has been avoided during operation to date by positioning the tuners to avoid high voltage appearing on the drive rods. A modified design for the drive rods will be implemented before RF operations resume operation June 1995. New transmitters were procured from ABB for the new antennas and were installed in parallel with the antenna installation. During initial vacuum conditioning of the antenna in the 180° port a fast digital oscilloscope was used to try to pinpoint the location of arcing by a time-of-flight technique and to develop an understanding of the typical arc signature in the system.

31208 (DOE/CH/03073–T74) **Potential safe termination by injection of polypropylene pellets in JET.** Schmidt, G.L. (Princeton Plasma Physics Lab., NJ (United States)); Ali-Arshad, S.; Bartlett, D. Princeton Univ., NJ (United States). Plasma Physics Lab. [1995]. 4p. Sponsored by USDOE, Washington, DC (United States). DOE Contract AC02-76CH03073. (CONF-9507182–1: European Physical Society conference, Bournmouth (United Kingdom), 3-7 Jul 1995). Order Number DE96001109. Source: OSTI; NTIS; INIS; GPO Dep.

Thermal energy and the magnetic field energy associated with the plasma current must be dissipated safely when a tokamak discharge is terminated in a disruption. Magnetic energy can be dissipated by impurity radiation if position control is maintained. Prior to the dissipation of magnetic energy, thermal energy is usually conducted to the plasma contact points on a 1ms time scale in a thermal quench. A resistive, highly radiating plasma formed prior to the thermal quench, might dissipate both the thermal and magnetic energy by radiation minimizing damage due to local deposition. High speed injection of a low Z material can produce a resistive, highly radiating plasma on a 1ms time scale. Neon has recently been used in such an application on JT60-U. A large carbon pellet producing dilution temperatures < 1 keV is a possible alternative. This paper summarizes the results of an initial experiment performed in JET using carbon injected at high speed, as a 6mm polypropylene pellet, to investigate this potential approach to a safe plasma termination.

31209 (DOE/EA–0813) **The Tokamak Fusion Test Reactor decontamination and decommissioning project and the Tokamak Physics Experiment at the Princeton Plasma Physics Laboratory. Environmental Assessment.** USDOE, Washington, DC (United States). 27 May 1994. 185p. Sponsored by USDOE, Washington, DC (United States). Order Number DE95012249. Source: OSTI; NTIS; GPO Dep.

If the US is to meet the energy needs of the future, it is essential that new technologies emerge to compensate for dwindling supplies of fossil fuels and the eventual depletion of fissionable uranium used in present-day nuclear reactors. Fusion energy has the potential to become a major source of energy for the future. Power from fusion energy would provide a substantially reduced environmental impact as compared with other forms of energy generation. Since fusion utilizes no fossil fuels, there would be no release of chemical combustion products to the atmosphere. Additionally, there are no fission products formed to present handling and disposal problems, and runaway fuel reactions are impossible due to the small amounts of deuterium and tritium present. The purpose of the TPX Project is to support the development of the physics and technology to extend tokamak operation into the continuously operating (steady-state) regime, and to demonstrate advances in fundamental tokamak performance. The purpose of TFTR D&D is to ensure compliance with DOE Order 5820.2A "Radioactive Waste Management" and to remove environmental and health hazards posed by the TFTR in a non-operational mode. There are two proposed actions evaluated in this environmental assessment (EA). The actions are related because one must take place before the other can proceed. The proposed actions assessed in this EA are: the decontamination and decommissioning (D&D) of the Tokamak Fusion Test Reactor (TFTR); to be followed by the construction and operation of the Tokamak Physics Experiment (TPX). Both of these proposed actions would take place primarily within the TFTR Test Cell Complex at the Princeton Plasma Physics Laboratory (PPPL). The TFTR is located on "D-site" at the James Forrestal Campus of

Princeton University in Plainsboro Township, Middlesex County, New Jersey, and is operated by PPPL under contract with the United States Department of Energy (DOE).

31210 (DOE/ER–0313/17, pp. 255-263) **An investigation of the desorption of hydrogen from lithium oxide using temperature programmed desorption and diffuse reflectance infrared spectroscopy.** Kopasz, J.P. (Argonne National Lab., Chicago, IL (United States)); Johnson, C.E.; Ortiz-Villafuerte, J. Oak Ridge National Lab., TN (United States). Apr 1995. In *Fusion materials semiannual progress report for the period ending September 30, 1994*. 390p. Order Number DE95013663. Source: OSTI; NTIS; INIS; GPO Dep.

The addition of hydrogen to the purge stream has been shown to enhance tritium release from ceramic breeder materials; however, this added hydrogen can lead to increased costs in the tritium purification system. The objective of this work is to develop an understanding of the interactions between hydrogen and lithium oxide surfaces so that the authors can take full advantage of the observed enhancement of tritium release caused by hydrogen addition without incurring high costs in the tritium purification plant.

31211 (DOE/SF–19460-91) **LLE Review: Volume 63. Quarterly report, April–June 1995.** Craxton, R.S. (ed.). Rochester Univ., NY (United States). Lab. for Laser Energetics. [1995]. 60p. Sponsored by USDOE, Washington, DC (United States). DOE Contract FC03-92SF19460. Order Number DE96000767. Source: OSTI; NTIS; INIS; GPO Dep.

This volume of the LLE Review, covering the period of April–June 1995, includes a description of the initial performance results of the upgraded OMEGA laser system. A series of acceptance tests were completed, demonstrating that all 60 beams can irradiate targets with more energy and better beam balance than was required by the Department of Energy's acceptance criteria. Other articles in this volume include a description of a novel energy measurement system used to diagnose all 60 OMEGA beams; a theoretical calculation of the cutoff wave number of the ablative Rayleigh-Taylor instability, applicable to both direct and indirect drive; a description of a new algorithm used for designing distributed phase plates that will produce super-Gaussian focal-plane irradiance profiles: a study of the photoresponse of high-T_cYBCO thin films; and a description of magnetorheological finishing, a new process for optics polishing.

31212 (GA-A–21935) **DIII-D Research Operations annual report to the US Department of Energy, October 1, 1993–September 30, 1994.** Lohr, J. (ed.) (General Atomics, San Diego, CA (United States)). General Atomics, San Diego, CA (United States); Lawrence Livermore National Lab., CA (United States); Oak Ridge National Lab., TN (United States). Jul 1995. 111p. Sponsored by USDOE, Washington, DC (United States). DOE Contract AC03-89ER51114 ; AC05-84OR21400 ; W-7405-ENG-48. Order Number DE95015977. Source: OSTI; NTIS; INIS; GPO Dep.

The DIII-D tokamak research program is managed by General Atomics (GA) for the US Department of Energy (DOE). Major program participants include GA, Lawrence Livermore National Laboratory (LLNL), Oak Ridge National Laboratory (ORNL), and the University of California together with several other national laboratories and universities. The DIII-D is a moderate sized tokamak with great flexibility and extremely capable subsystems. The primary goal of the DIII-D tokamak research program is to provide data for development of a conceptual physics blueprint for a commercially attractive fusion power plant. In so doing, the DIII-D program provides physics and technology R&D output to aid the International Thermonuclear Experimental Reactor (ITER) and the Princeton Tokamak Physics Experiment (TPX) projects. Specific DIII-D objectives include the achievement of steady-state plasma current as well as the demonstration of techniques for radio frequency heating, divertor heat removal, particle exhaust and tokamak plasma control. The DIII-D program is addressing these objectives in an integrated fashion in plasmas with high beta and with high confinement. The long-range plan is organized with two principal elements, the development of an advanced divertor and the development of advanced tokamak concepts. These two elements have a common goal: an improved demonstration reactor (DEMO) with lower cost and smaller size than present DEMO concepts. In order to prepare for this long-range development, in FY94 the DIII-D research program concentrated on three major areas: Divertor and Boundary Physics, Advanced Tokamak studies, and Tokamak Physics.

31213 (GA–A22038) **Study of electron temperature profile evolution during L-H transition with measurement of electron cyclotron emission on DIII-D.** Wang, Z. (Southwest Inst. of Physics, Sichuan, SC (China)); Hsieh, C.; Zhang, J.; Lohr, J.; Stockdale, R.E.; Bell, G.L.; Wilgen, J.B.; Luo, J. General Atomics, San Diego, CA (United States). Jun 1995. 12p. Sponsored by USDOE, Washington, DC (United States). DOE Contract AC03-89ER51114. (CONF-950112–5: 9. joint workshop on electron cyclotron emission and electron cyclotron resonance heating, Borrego Springs, CA (United States), 23-26 Jan 1995). Order Number DE95017845. Source: OSTI; NTIS; INIS; GPO Dep.

The L-H transition has been intensively investigated since it was discovered in the ASDEX tokamak in 1982. Considerable experimental evidence shows that the formation of the transport barrier at the plasma edge, during which the edge density and temperature gradients suddenly increase, is a common feature in the L-H transition discharge in all devices. Formation of the transport barrier is indicated by a sharp reduction in the $D\alpha$ radiation at the periphery of the plasma despite a simultaneous increase in the plasma density. A new heterodyne electron cyclotron emission radiometer, which had been built for the ATF device at the Oak Ridge National Laboratory, has been installed on DIII-D. The instrument features 32 channels with high temporal and spatial resolution and covers the outer half of DIII-D plasma at full magnetic field. Initial measurements with the instrument at the time of the L-H transition show that there is no T_e, precursor to the transition and this is further supported by observations during dithering L-H transition where the transport barrier is immediately destroyed when the plasma briefly returns to the L-mode during process of the transition. Other applications of the new instrument have included T_e, profile measurements during edge localized modes and during Ohmic and beam-heated sawteeth, which highlight the magnetic reconnection process. The instrument will be described and some of these results win be presented.

31214 (GA-A–22081) **Direct electron heating with directional fast wave launch on DIII-D.** Pinsker, R.I. (General Atomics, San Diego, CA (United States)); Chiu, S.C.; Baity, F.W. General Atomics, San Diego, CA (United States); Lawrence Livermore National Lab., CA (United States). Jul 1995. 4p. Sponsored by USDOE, Washington, DC (United States). DOE Contract AC03-89ER51114 ; W-7405-ENG-48. (CONF-9505105–14: 11. topical conference on radio frequency in plasmas, Palm Springs, CA (United States), 17-19 May 1995). Order Number DE95016481. Source: OSTI; NTIS; INIS; GPO Dep.

Direct electron heating obtained with a four-element array phased at $(0, \pi/2, \pi, 3\pi/2)$ without a Faraday shield is compared with that obtained with a Faraday shield on the same antenna.

31215 (GA-C–21941) **ITER convertible blanket evaluation.** Wong, C.P.C.; Cheng, E. Raytheon Engineers and Constructors, Inc., Philadelphia, PA (United States). [1995]. 29p. Sponsored by USDOE, Washington, DC (United States). DOE Contract AC03-94SF20282. Order Number DE95017612. Source: OSTI; NTIS; INIS; GPO Dep.

Proposed International Thermonuclear Experimental Reactor (ITER) convertible blankets were reviewed. Key design difficulties were identified. A new particle filter concept is introduced and key performance parameters estimated. Results show that this particle filter concept can satisfy all of the convertible blanket design requirements except the generic issue of Be blanket lifetime. If the convertible blanket is an acceptable approach for ITER operation, this particle filter option should be a strong candidate.

31216 (IAEA-ITEREDA/DS–06) **ITER Council proceedings: 1994.** ITER EDA documentation series, no.6. International Atomic Energy Agency, Vienna (Austria). 1995. 245p. Order Number DE96602912. Source: OSTI; NTIS (US Sales Only); INIS.

This issue in the ITER EDA (engineering Design Activities) Series contains the documents of the fifth, sixth, and seventh ITER Council Meetings (IC-5, IC-6, and IC-7).

31217 (INIS-mf–14577) **ITER EDA Newsletter. V. 4, no. 3.** International Atomic Energy Agency, Vienna (Austria). Mar 1995. 8p. Order Number DE96602913. Source: OSTI; NTIS (US Sales Only); INIS.

This ITER EDA (Engineering Design Activities) Newsletter issue reports on (i) the ITER Magnet Technical Meeting held at the Naka Joint Work Site on February 7-10, 1995; (ii) the Second Technical Meeting on ITER Power Supply held on February 20-24, 1995, in St. Petersburg (Russian Federation); and (iii) a description by the Nuclear Data section of the IAEA (Vienna, Austria) on the availability and current status of the FENDL-1 Nuclear Data Libraries for fusion applications.

31218 (INIS-mf–14578) **ITER EDA Newsletter. V. 4, no. 4.** International Atomic Energy Agency, Vienna (Austria). Apr 1995. 5p. Order Number DE96602914. Source: OSTI; NTIS (US Sales Only); INIS.

This issue of the ITER EDA (Engineering Design Activities) Newsletter reports on (i) the Second Meeting of the ITER Physics Expert Group on Diagnostics held at the Japanese Atomic Energy Research Institute, Naka, Japan, on February 8-10, 1995; and (ii) a summary of the Second Workshop of the Confinement Modelling and Database Expert Group, held at the ITER San Diego Work Site, March 13-15, 1995.

31219 (INIS-mf–14579) **ITER EDA Newsletter. V. 4, no. 5.** International Atomic Energy Agency, Vienna (Austria). May 1995. 4p. Order Number DE96602915. Source: OSTI; NTIS (US Sales Only); INIS.

This issue of the ITER EDA (Engineering Design Activities) Newsletter contains comments on the ITER project by the Permanent Representative of the Russian Federation to the International Organizations in Vienna; a report on the ITER Magnet Technical Meeting held at the Joint Work Site at Naka, Japan, April 19-21, 1995; and a contribution entitled "ITER spouses cross the cultures".

31220 (INIS-mf–14580) **ITER EDA Newsletter. V. 4, no. 6.** International Atomic Energy Agency, Vienna (Austria). Jun 1995. 6p. Order Number DE96602916. Source: OSTI; NTIS (US Sales Only); INIS.

This issue of the ITER EDA (Engineering Design Activities) Newsletter contains a report on the TAC-JCT (Technical Advisory Committee, Joint Technical Team) Informal Technical Reviews and the State Duma Hearings on Fusion (i.e., Parliamentary Hearing on Fusion held in the Russian Federation).

31221 (JAERI-Tech–95-032) **Feasibility study of first wall electrical connector.** Kitamura, Kazunori (Japan Atomic Energy Research Inst., Naka, Ibaraki (Japan). Naka Fusion Research Establishment); Takatsu, Hideyuki; Koizumi, Kouichi; Tsunematsu, Toshihide. Japan Atomic Energy Research Inst., Tokyo (Japan). May 1995. 22p. Order Number DE96701317. Source: OSTI; NTIS; INIS.

A feasibility study of first wall electrical connector concept has been performed to mitigate plasma disruption effect of electromagnetic force on the blanket structure. A multi-layered thin copper plate was applied to the connector structure, which was installed between adjacent first walls with keys and bolts. An optimization on the connector mechanical stiffness was performed to withstand the large electromagnetic forces at the plasma disruption and to absorb the module displacement between adjacent blanket structures due to thermal expansion of the modular blanket. As the results, a possible structural solution of the first wall electrical connector concept has been developed, which seems feasible in the views of mechanical integrity and fabricability, however, further detailed study on the connector feasibility is required. (author).

31222 (JAERI-Tech–95-033) **Fabrication and high heat flux test of divertor cooling elements.** Suzuki, Satoshi (Japan Atomic Energy Research Inst., Naka, Ibaraki (Japan). Naka Fusion Research Establishment); Araki, Masanori; Nakamura, Kazuyuki; Satoh, Kazuyoshi; Yokoyama, Kenji; Dairaku, Masayuki; Akiba, Masato. Japan Atomic Energy Research Inst., Tokyo (Japan). Jun 1995. 68p. Order Number DE96701318. Source: OSTI; NTIS; INIS.

The plasma facing components in ITER are subjected to a high heat flux from fusion plasma. The heat flux is not only higher than that of existing tokamaks but also has a longer pulse duration (burn time). To minimize a peaking of the heat flux, the thermal deformation towards the plasma should be restrained. One-meter-long monoblock divertor modules with a sliding support structure were fabricated and tested at JAERI. Two kinds of support mechanisms were provided to minimize the thermal deformation of the modules in the upward and downward directions ; one is a pin type sliding structure and the other is a rail type support structure. Both modules were tested on the electron beam HHF test facility, JEBIS (JAERI Electron Beam Irradiation System), in JAERI. The steady-state heat flux of 15 MW/m^2 was applied to the surface of the modules to simulate the design condition of ITER CDA. As a result of the HHF test, the performance of the sliding support structures was successfully demonstrated. Three dimensional elastic stress analyses were conducted using a finite element method. The result shows that the relatively high thermal stress is observed at the cooling tube ; and that the maximum thermal stress at the cooling tube exceeds its yield strength. It is necessary to perform the lifetime evaluation of the copper cooling tube against cyclic thermal stresses. (author).

31223 (LA-UR–95-2815) **Capacitor and rail-gap development for the Atlas machine Marx modules.** Reass, W.A. (Los Alamos National Lab., NM (United States)); Bowman, D.W.; Gribble, R.F.; Griego, J.R.; Thompson, C.; Parsons, W.M.; Cooper, R.A.; Casper, D.C. Los Alamos National Lab., NM (United States). [1995]. 8p. Sponsored by USDOE, Washington, DC (United States). DOE Contract W-7405-ENG-36. (CONF-950750–35: 10. Institute of Electrical and Electronics Engineers (IEEE) pulsed power conference, Albuquerque, NM (United States), 10-13 Jul 1995). Order Number DE95016929. Source: OSTI; NTIS; INIS; GPO Dep.

This paper presents the engineering issues and development criteria utilized to evolve the Atlas Marx bank pulse power components. The capacitor and rail-gap required alterations from existing designs to minimize system inductance and component count, maximize reliability, and enhance maintainability. For the capacitors, development has resulted in a plastic cased device with double ended bushings. The design of the capacitors' output electrodes, foil packs, and internal interconnect webbing results in a capacitor with improved performance. The capacitors are rated at 33.5 uF and 60 kV and are housed in a 28 in. x 29 in. x 13 in. fiberglass case. Terminal inductance is less than 15 nH with a design discharge current greater than 650 kA. An improved "third generation" rail-gap will be utilized and is a product of the ACE machine developments at Maxwell Laboratories. The gap has a polyurethane body and one piece electrodes. To minimize prefires, a modified internal profile reduces the E-field and increases tracking length between the electrodes. With an individual Marx stage charged "+" and "–" and a trigger rail with 50/50 grading (midplane), external trigger bias or coupling components are not required. This further reduces system component count. To further reduce gap prefires and environmental concerns, high pressure air, instead of the typical Argon/SF6 mixture, will be used. The metallic switching by-products will form insulating oxides and the gap flushing procedures are simplified. To ensure multi-channel discharges, fast dV/dT trigger voltages (~30 kV/nS), similar to those developed for the Staged Theta-Pinch railgaps (a Scyllac era machine at Los Alamos), will be utilized.

31224 (LA-UR–95-2816) **Design of the individual Marx modules for the Atlas machine 36 megajoule, 25 megampere capacitor bank.** Reass, W.A.; Bowman, D.W.; Gribble, R.F.; Griego, J.R.; Thompson, C.; Parsons, W.M. Los Alamos National Lab., NM (United States). [1995]. 6p. Sponsored by USDOE, Washington, DC (United States). DOE Contract W-7405-ENG-36. (CONF-950750–34: 10. Institute of Electrical and Electronics Engineers (IEEE) pulsed power conference, Albuquerque, NM (United States), 10-13 Jul 1995). Order Number DE95016928. Source: OSTI; NTIS; INIS; GPO Dep.

This paper presents the preliminary electrical and mechanical design of the Atlas machine's 1.8 megajoule, 600 kV Marx modules. The modules are implemented with plastic cased capacitors similar to those developed for the Defense Nuclear Agency (DNA)

ACE II and ACE IV machines. The double ended electrode capacitor style has been dubbed "FASTCAP." Electrodes are provided for mounting rail-gaps on one side and flat plate transmission line damping resistors on the other. This provides for an extremely low circuit inductance. A series array of ten capacitors, each rated at 60 kV, 33.5 uF, and 60 kJ, with their five triggered rail-gaps, form a Marx submodule. Three Marx submodules are nested into a large G-10 fiberglass rack to form a complete Marx module. The module support rack has individual capacitor shelves that ease assembly and replacement. The Marx's design also facilitates construction, testing and verification of a modules performance prior to installation. Modules will be repaired or maintained in a separate test bay without affecting machine operation schedules. Railgap maintenance will become part of a regularly-scheduled preventative maintenance program as spare modules are installed and removed from the machine.

31225 (LA-UR–95-2868) **The Los Alamos/Arzamas-16 collaboration of ultrahigh magnetic fields and ultrahigh energy pulsed power.** Chernyshev, V.K. (All-Russian Scientific Research Institute of Experimental Physics, Arzamas-16, Nizhni Novgorod Region (Russian Federation)); Mokhov, V.N.; Pavlovskii, A.I.; Ekdahl, C.A.; Fowler, C.M.; Reinovsky, R.E.; Younger, S.M. Los Alamos National Lab., NM (United States). [1995]. 20p. Sponsored by USDOE, Washington, DC (United States). DOE Contract W-7405-ENG-36. (CONF-950750–40: 10. Institute of Electrical and Electronics Engineers (IEEE) pulsed power conference, Albuquerque, NM (United States), 10-13 Jul 1995). Order Number DE96000010. Source: OSTI; NTIS; GPO Dep.

The end of the Cold War has made possible some remarkable scientific adventures–joint research projects between scientific institutions of the United States and the Russian Federation. Perhaps most unprecedented of the new partnerships is a formal collaboration which has been established between the All-Russian Scientific Research Institute of Experimental Physics and the Los Alamos National Laboratory (LANL), the two institutes which designed the first nuclear weapons for their respective countries. In early 1992, emerging governmental policy in the US and Russia began to encourage "lab-to-lab" interactions between the nuclear weapons design laboratories of the two countries. Each government recognized that as nuclear weapons stockpiles and design activities were being reduced, highly qualified scientists were becoming available to use their considerable skills in fundamental scientific research of interest to both nations. VNIIEF and LANL quickly recognized a common interest in the technology and applications of magnetic flux compression, the technique for converting the chemical energy released by high-explosives into intense electrical pulses and intensely concentrated magnetic energy. This document reports on current projects of the collaboration.

31226 (LA-UR–95-17922, pp. 889) **The PIREX proton irradiation facility.** Victoria, M. (Association EURATOM, Villigen (Switzerland)). Los Alamos National Lab., NM (United States). [1995]. (CONF-9407103–: International conference on accelerator-driven transmutation technologies and applications, Las Vegas, NV (United States), 25 Jul - 1 aug 1994). In *AIP conference on accelerator driven transmutation technologies and applications, Los Vegas, Nevada, July 25-29, 1994.* 958p. Order Number DE95014018. Source: OSTI; NTIS; INIS.

The proton Irradiation Experiment (PIREX) is a materials irradiation facility installed in a beam line of the 590 MeV proton accelerator at the Paul Scherrer Institute. Its main purpose is the testing of candidate materials for fusion reactor components. Protons of this energy produce simultaneously displacement damage and spallation products, amongst them helium and can therefore simulate any possible synergistic effects of damage and helium, that would be produced by the fusion neutrons.

31227 (LBL–36541) **Beam dynamics in heavy ion fusion.** Seidl, P. Lawrence Berkeley Lab., CA (United States). Apr 1995. 5p. Sponsored by USDOE, Washington, DC (United States). DOE Contract AC03-76SF00098. (CONF-950512–299: Particle accelerator conference, Dallas, TX (United States), 1-5 May 1995). Order Number DE95014794. Source: OSTI; NTIS; INIS; GPO Dep.

A standard design for heavy ion fusion drivers under study in the US is an induction linac with electrostatic focusing at low energy and magnetic focusing at higher energy. The need to focus the intense beam to a few-millimeter size spot at the deuterium-tritium target establishes the emittance budget for the accelerator. Economic and technological considerations favor a larger number of beams in the low-energy, electrostatic-focusing section than in the high-energy, magnetic-focusing section. Combining four beams into a single focusing channel is a viable option, depending on the growth in emittance due to the combining process. Several significant beam dynamics issues that are, or have been, under active study are discussed: large space charge and image forces, beam wall clearances, halos, alignment, longitudinal instability, and bunch length control.

31228 (LBL–36542) **Heavy Ion fusion 2 MV injector.** Yu, S. (Lawrence Berkeley Lab., CA (United States). Accelerator and Fusion Research Div.); Eylon, S.; Henestroza, E. Lawrence Berkeley Lab., CA (United States). Apr 1995. 5p. Sponsored by USDOE, Washington, DC (United States). DOE Contract AC03-76SF00098. (CONF-950512–324: Particle accelerator conference, Dallas, TX (United States), 1-5 May 1995). Order Number DE96000133. Source: OSTI; NTIS; INIS; GPO Dep.

A heavy-ion-fusion driver-scale injector has been constructed and operated at Lawrence Berkeley Laboratory. The injector has produced 2.3 MV and 950 mA of K^+, 15% above original design goals in energy and current. Normalized edge emittance of less than 1 π mm-mr was measured over a broad range of parameters. The head-to-tail energy flatness is less than $\pm$ 0.2% over the 1 μs pulse.

31229 (LBL–36622) **Beam dynamics studies of the Heavy Ion Fusion Accelerator injector.** Henestroza, E. (Lawrence Berkeley Lab., CA (United States). Accelerator and Fusion Research Div.); Yu, S.S.; Eylon, S.; Grote, D.P. Lawrence Berkeley Lab., CA (United States). Apr 1995. 3p. Sponsored by USDOE, Washington, DC (United States). DOE Contract AC03-76SF00098. (CONF-950512–318: Particle accelerator conference, Dallas, TX (United States), 1-5 May 1995). Order Number DE96000117. Source: OSTI; NTIS; INIS; GPO Dep.

A driver-scale injector for the Heavy Ion Fusion Accelerator project has been built at LBL. This machine has exceeded the design goals of high voltage (> 2 MV), high current (> 0.8 A of K^+) and low normalized emittance (< 1 π mm-mr). The injector consists of a 750 keV diode pre-injector followed by an electrostatic quadrupole accelerator (ESQ) which provides strong (alternating gradient) focusing for the space-charge dominated beam and simultaneously accelerates the ions to 2 MeV. The fully 3-D PIC code WARP together with EGUN and POISSON were used to design the machine and analyze measurements of voltage, current and phase space distributions. A comparison between beam dynamics characteristics as measured for the injector and corresponding computer calculations will be presented.

31230 (NISTIR–5013) **Electromechanical properties of superconductors for DOE fusion applications.** Ekin, J.W.; Bray, S.L.; Lutgen, C.L.; Bahn, W.L. National Inst. of Standards and Technology (NEL), Boulder, CO (United States). Electromagnetic Technology Div. Jan 1994. 53p. Sponsored by USDOE, Washington, DC (United States);Department of Commerce, Washington, DC (United States). DOE Contract AI01-84ER52113. Order Number DE95015476. Source: OSTI; NTIS; INIS; GPO Dep.

The electrical performance of many superconducting materials is strongly dependent on mechanical load. This report presents electromechanical data on a broad range of high-magnetic-field superconductors. The conductors that were studied fall into three general categories: Candidate conductors, experimental conductors, and reference conductors. Research on candidate conductors for fusion applications provides screening data for superconductor selection as well as engineering data for magnet design and performance analysis. The effect of axial tensile strain on critical-current density was measured for several Nb_3Sn candidate conductors including the US-DPC (United States Demonstration Poloidal Coil) cable strand and an ITER (International Thermonuclear Experimental Reactor) candidate conductor. Also, data are presented on promising experimental superconductors that have strong potential for fusion applications. Axial strain measurements were made on a V_3Ga tape conductor that has good performance

at magnetic fields up to 20 T. Axial strain data are also presented for three experimental Nb_3Sn conductors that contain dispersion hardened copper reinforcement for increased tensile strength. Finally, electromechanical characteristics were measured for three different Nb_3Sn reference conductors from the first and second VAMAS (Versailles Project on Advanced Materials and Standards) international Nb_3Sn critical-current round robins. Published papers containing key results, including the first measurement of the transverse stress effect in Nb_3Sn, the effect of stress concentration at cable-strand crossovers, and electromechanical characteristics of Nb_3Al, are included throughout the report.

31231 (NUREG/CP–0142-Vol.1, pp. 532-553) **An experimental investigation of the post-CHF enhancement factor for a prototypical ITER divertor plate with water coolant.** Marshall, T.D. (Rensselaer Polytechnic Institute, Troy, NY (United States)); Watson, R.D.; McDonald, J.M. Nuclear Regulatory Commission, Washington, DC (United States). Div. of Systems Technology; American Nuclear Society, La Grange Park, IL (United States); American Inst. of Chemical Engineers, New York, NY (United States); American Society of Mechanical Engineers, New York, NY (United States); Canadian Nuclear Society, Toronto, ON (Canada); Japan Society of Multiphase Flow, Kyoto (Japan). Sep 1995. (CONF-950904–Vol.1: 7. international meeting on nuclear reactor thermal hydraulics, Saratoga, NY (United States), 10-15 Sep 1995). In *Proceedings of the 7th International Meeting on Nuclear Reactor Thermal-Hydraulics NURETH-7. Volume 1, Sessions 1-5.* 862p. Source: OSTI; NTIS; INIS; GPO.

In an off-normal event, water-cooled copper divertor plates in the International Thermonuclear Experimental Reactor (ITER) may either experience heat loads beyond their design basis, or the normal heat loads may be accompanied by low coolant pressure and velocity. The purpose of this experiment was to illustrate that during one-sided heating, as in ITER, a copper divertor plate with the proper side wall thickness, at low system pressure and velocity can absorb without failing an incident heat flux, q_i, that significantly exceed the value, q_i^{CHF}, which is associated with local CHF at the wall of the coolant channel. The experiment was performed using a 30 kW electron beam test system for heating of a square cross-section divertor heat sink with a smooth circular channel of 7.63 mm diameter. The heated width, length, and wall thickness were 16, 40, and 3 mm, respectively. Stable surface temperatures were observed at incident heat fluxes greater than the local CHF point, presumably due to circumferential conduction around the thick tube walls when q_i^{CHF} was exceeded. The Post-CHF enhancement factor, η, is defined as the ratio of the incident burnout heat flux, q_i^{BO}, to q_i^{CHF}. For this experiment with water at inlet conditions of 70°C, 1 m/s, and 1 MPa, q_i^{CHF} and q_i^{BO} were 600 and 1100 W/cm^2, respectively, which gave an η of 1.8.

31232 (NUREG/CP–0142-Vol.2, pp. 933-946) **Rayleigh-Taylor instability of cylindrical jets with radial motion.** Chen, Xiang M. (GE Nuclear, Wilmington, NC (United States)); Schrock, V.E.; Peterson, P.F. Nuclear Regulatory Commission, Washington, DC (United States). Div. of Systems Technology; American Nuclear Society, La Grange Park, IL (United States); American Inst. of Chemical Engineers, New York, NY (United States); American Society of Mechanical Engineers, New York, NY (United States); Canadian Nuclear Society, Toronto, ON (Canada); European Nuclear Society (ENS), Bern (Switzerland); Atomic Energy Society of Japan, Tokyo (Japan); Japan Society of Multiphase Flow, Kyoto (Japan). Sep 1995. (CONF-950904–Vol.2: 7. international meeting on nuclear reactor thermal hydraulics, Saratoga, NY (United States), 10-15 Sep 1995). In *Proceedings of the 7th International Meeting on Nuclear Reactor Thermal-Hydraulics NURETH-7. Volume 2, Sessions 6-11.* 795p. Source: OSTI; NTIS; INIS; GPO.

Rayleigh-Taylor instability of an interface between fluids with different densities subjected to accelleration normal to itself has interested researchers for almost a century. The classic analyses of a flat interface by Rayleigh and Taylor have shown that this type of instability depends on the direction of acceleration and the density differences of the two fluids. Plesset later analyzed the stability of a spherically symmetric flows (and a spherical interface) and concluded that the instability also depends on the velocity of the interface as well as the direction and magnitude of radial acceleration. The instability induced by radial motion in cylindrical systems seems to have been neglected by previous researchers. This paper analyzes the Rayleigh-Taylor type of the spherical case, the radial velocity also plays an important role. As an application, the example of a liquid jet surface in an Inertial Confinement Fusion (ICF) reactor design is analyzed.

31233 (NUREG/CP–0142-Vol.4, pp. 2506-2518) **A formal approach for the prediction of the critical heat flux in subcooled water.** Lombardi, C. (Polytechnic of Milan (Italy)). Nuclear Regulatory Commission, Washington, DC (United States). Div. of Systems Technology; American Nuclear Society, La Grange Park, IL (United States); American Inst. of Chemical Engineers, New York, NY (United States); American Society of Mechanical Engineers, New York, NY (United States); Canadian Nuclear Society, Toronto, ON (Canada); European Nuclear Society (ENS), Bern (Switzerland); Atomic Energy Society of Japan, Tokyo (Japan); Japan Society of Multiphase Flow, Kyoto (Japan). Sep 1995. (CONF-950904–Vol.4: 7. international meeting on nuclear reactor thermal hydraulics, Saratoga, NY (United States), 10-15 Sep 1995). In *Proceedings of the 7th International Meeting on Nuclear Reactor Thermal-Hydraulics NURETH-7. Sessions 17-24.* 825p. Source: OSTI; NTIS; INIS; GPO.

The critical heat flux (CHF) in subcooled water at high mass fluxes are not yet satisfactory correlated. For this scope a formal approach is here followed, which is based on an extension of the parameters and the correlation used for the dryout prediction for medium high quality mixtures. The obtained correlation, in spite of its simplicity and its explicit form, yields satisfactory predictions, also when applied to more conventional CHF data at low-medium mass fluxes and high pressures. Further improvements are possible, if a more complete data bank will be available. The main and general open item is the definition of a criterion, depending only on independent parameters, such as mass flux, pressure, inlet subcooling and geometry, to predict whether the heat transfer crisis will result as a DNB or a dryout phenomenon.

31234 (ORNL/TM–13009) **Particle exhaust of helium plasmas with actively cooled outboard pump limiter on Tore Supra.** Uckan, T. (Oak Ridge National Lab., TN (United States)); Mioduszewski, P.K.; Loarer, T.; Chatelier, M.; Guilhem, D.; Lutz, T.; Nygren, R.E.; Mahdavi, M.A. Oak Ridge National Lab., TN (United States). Aug 1995. 13p. Sponsored by USDOE, Washington, DC (United States). DOE Contract AC05-84OR21400. (CONF-950704–12: 22. European conference on controlled fusion and plasma physics, Bournemouth (United Kingdom), 2-7 Jul 1995). Order Number DE96000177. Source: OSTI; NTIS; INIS; GPO Dep.

The superconducting tokamak Tore Supra was designed for long-pulse (30-s) high input power operation. Here observations on the particle-handling characteristics of the actively cooled modular outboard pump limiter (OPL) are presented for helium discharges. The important experimental result was that a modest pumping speed (1 m^3/s) of the OPL turbomolecular pump (TMP) provided background helium exhaust. This result came about due to a well-conditioned vessel wall with helium discharges that caused no wall outgasing. The particle accountability in these helium discharges was excellent, and the well-conditioned wall did not play a significant role in the particle balance. The helium density control, 25% density drop with OPL exhaust efficiency of ~1%, was possible with TMP although this may not be the case with reactive gases such as deuterium. The observed quadratic increase of the OPL neutral pressure with helium density was consistent with an improvement of the particle control with increasing plasma density.

31235 (SAND–94-3136C) **Cleaning techniques for applied-B ion diodes.** Cuneo, M.E. (and others); Menge, P.R.; Hanson, D.L. Sandia National Labs., Albuquerque, NM (United States). [1995]. 10p. Sponsored by USDOE, Washington, DC (United States). DOE Contract AC04-94AL85000. (CONF-950750–38: 10. Institute of Electrical and Electronics Engineers (IEEE) pulsed power conference, Albuquerque, NM (United States), 10-13 Jul 1995). Order Number DE95017882. Source: OSTI; NTIS; GPO Dep.

Measurements and theoretical considerations indicate that the lithium-fluoride (LiF) lithium ion source operates by electron-assisted field-desorption, and provides a pure lithium beam for

10–20 ns. Evidence on both the SABRE (1 TW) and PBFA-II (20 TW) accelerators indicates that the lithium beam is replaced by a beam of protons, and carbon resulting from electron thermal desorption of hydrocarbon surface and bulk contamination with subsequent avalanche ionization. Appearance of contaminant ions in the beam is accompanied by rapid impedance collapse, possibly resulting from loss of magnetic insulation in the rapidly expanding and ionizing, neutral layer. Electrode surface and source substrate cleaning techniques are being developed on the SABRE accelerator to reduce beam contamination, plasma formation, and impedance collapse. We have increased lithium current density a factor of 3 and lithium energy a factor of 5 through a combination of in-situ surface and substrate coatings, impermeable substrate coatings, and field profile modifications.

31236 (SAND–95-0804C) **Erosion and deposition of metals and carbon in the DIII-D divertor.** Wampler, W.R. (and others); Bastasz, R.; Buchenauer, D. Sandia National Labs., Albuquerque, NM (United States); Sandia Labs., Livermore, CA (United States). [1995]. 18p. Sponsored by USDOE, Washington, DC (United States). DOE Contract AC04-94AL85000 ; AC03-89ER51114. (CONF-950961–1: 7. international conference on fusion reactor materials, Obninsk (Russian Federation), 25-29 Sep 1995). Order Number DE96000776. Source: OSTI; NTIS; INIS; GPO Dep.

Net erosion rates at the outer strike point of the DIII-D divertor plasma were measured for several materials during quiescent H-mode operation with deuterium plasmas. Materials examined include graphite, beryllium, tungsten, vanadium and molybdenum. For graphite, net erosion rates up to 4 nm/sec were found. Erosion rates for the metals were much smaller than for carbon. Ion fluxes from Langmuir probe measurements were used to predict gross erosion by sputtering. Measured net erosion was much smaller than predicted gross erosion. Transport of metal atoms by the plasma across the divertor surface was also examined. Light atoms were transported farther than heavy atoms as predicted by impurity transport models.

31237 (SAND–95-1693) **Report of a technical evaluation panel on the use of beryllium for ITER plasma facing material and blanket breeder material.** Ulrickson, M.A. (ed.) (Sandia National Labs., Albuquerque, NM (United States)); Manly, W.D.; Dombrowski, D.E. Sandia National Labs., Albuquerque, NM (United States). Aug 1995. 150p. Sponsored by USDOE, Washington, DC (United States). DOE Contract AC04-94AL85000. Order Number DE96000055. Source: OSTI; NTIS; INIS; GPO Dep.

Beryllium because of its low atomic number and high thermal conductivity, is a candidate for both ITER first wall and divertor surfaces. This study addresses the following: why beryllium; design requirements for the ITER divertor; beryllium supply and unirradiated physical/mechanical property database; effects of irradiation on beryllium properties; tritium issues; beryllium health and safety; beryllium-coolant interactions and safety; thermal and mechanical tests; plasma erosion of beryllium; recommended beryllium grades for ITER plasma facing components; proposed manufacturing methods to produce beryllium parts for ITER; emerging beryllium materials; proposed inspection and maintenance techniques for beryllium components and coatings; time table and costs; and the importance of integrating materials and manufacturing personnel with designers.

31238 (UCRL-ID–114972-2, pp. 8, Paper 10) **Beamlet diagnostics.** Theys, M. Lawrence Livermore National Lab., CA (United States). 6 May 1994. (CONF-9405328–Absts.: Science and Engineering Research Semester (SERS) student symposium, Livermore, CA (United States), 6 May 1994). In *SERS intership: Spring 1994 abstracts and research papers*. 195p. Order Number DE95014118. Source: OSTI; NTIS; GPO Dep.

Beamlet is a high power laser currently being built at Lawrence Livermore National Lab as a proof of concept for the National Ignition Facility (NIF). Beamlet is testing several areas of laser advancements, such as a 37cm Pockels cell, square amplifier, and propagation of a square beam. The diagnostics on beamlet tell the operators how much energy the beam has in different locations, the pulse shape, the energy distribution, and other important information regarding the beam. This information is being used to evaluate new amplifier designs, and extrapolate performance to the NIF laser. In my term at Lawrence Livermore National Laboratory I have designed and built a diagnostic, calibrated instruments used on diagnostics, setup instruments, hooked up communication lines to the instruments, and setup computers to control specific diagnostics.

31239 (UCRL-ID–118509) **Update on diode-pumped solid-state laser experiments for inertial fusion energy.** Marshall, C.; Smith, L.; Payne, S. Lawrence Livermore National Lab., CA (United States). 15 Aug 1994. 26p. Sponsored by USDOE, Washington, DC (United States). DOE Contract W-7405-ENG-48. Order Number DE95017715. Source: OSTI; NTIS; INIS; GPO Dep.

The authors have completed the initial phase of the diode-pumped solid-state laser (DPSSL) experimental program to validate the expected pumping dynamics and extraction cross-sections of Yb^{3+}-doped $Sr_5(PO_4)_3F$ (Yb:S-FAP) crystals. Yb:S-FAP crystals up to 25 x 25 x 175 mm in size have been grown for this purpose which have acceptable loss characteristics (<1 %/cm) and laser damage thresholds (~20 J/cm^2). The saturation fluence for pumping has been measured to be 2.2 J/cm^2 using three different methods based on either the spatial, temporal, or energy transmission properties of a Yb:S-FAP rod. The small signal gain under saturated pumping conditions was measured. These measurements imply an emission cross section of 6.0×10^{-20} cm^2 that falls within error bars of the previously reported value of 7.3×10^{-20} cm^2, obtained from purely spectroscopic techniques. The effects of radiation trapping on the emission lifetime have been quantified. The long lifetime of Yb:S-FAP has beneficial effects for diode-pumped amplifier designs, relative to materials with equivalent cross sections but shorter lifetimes, in that less peak pump intensity is required (thus lower diode costs) and that lower spontaneous emission rates lead to a reduction in amplified spontaneous emission. Consequently, up to 1.7 J/cm^3 of stored energy density was achieved in a 6x6x44 mm Yb:S-FAP amplifier rod; this stored energy density is large relative to typical flashlamp-pumped Nd:glass values of 0.3 to 0.5 J/cm^3. A 2.4 kW peak power InGaAs diode array has been fabricated by Beach, Emanuel, and co-workers which meets the central wavelength, bandwidth, and energy specifications for the author's immediate experiments. These results further increase their optimism of being able to produce a ~ 10% efficient diode-pumped solid state laser for inertial fusion energy.

31240 (UCRL-ID–120238) **Final report on the LLNL compact torus acceleration project.** Eddleman, J.; Hammer, J.; Hartman, C.; McLean, H.; Molvik, A. Lawrence Livermore National Lab., CA (United States). 19 Mar 1995. 50p. Sponsored by USDOE, Washington, DC (United States). DOE Contract W-7405-ENG-48. Order Number DE95017074. Source: OSTI; NTIS; INIS; GPO Dep.

In this report, we summarize recent work at LLNL on the compact torus (CT) acceleration project. The CT accelerator is a novel technique for projecting plasmas to high velocities and reaching high energy density states. The accelerator exploits magnetic confinement in the CT to stably transport plasma over large distances and to directed kinetic energies large in comparison with the CT internal and magnetic energy. Applications range from heating and fueling magnetic fusion devices, generation of intense pulses of x-rays or neutrons for weapons effects and high energy-density fusion concepts.

31241 (UCRL-ID–120758) **Configuring the National Ignition Facility for direct-drive experiments.** Eimerl, D. (ed.). Lawrence Livermore National Lab., CA (United States). Jul 1995. 90p. Sponsored by USDOE, Washington, DC (United States). DOE Contract W-7405-ENG-48. Order Number DE95017854. Source: OSTI; NTIS; GPO Dep.

The National Ignition Facility (NIF) is a project whose primary mission is to provide an above-ground experimental capability for maintaining nuclear competence and weapons effects simulation, and to pursue the achievement of fusion ignition utilizing solid state lasers as the energy driver. In this facility a large number of laser beams are focused onto a small target located at the center of a spherical target chamber. The laser energy is delivered in a few billionths of a second, raising the temperature and density of the nuclear materials in the target to levels where significant thermonuclear energy is released. The thermonuclear reaction proceeds very rapidly, so that the target materials remain confined by their own

inertia during the thermonuclear reaction. This type of approach is called inertial confinement fusion (ICF). The proposed project is described in a conceptual design report (CDR) that was released in May 1994. Early in FY95, a collaboration between the University of Rochester and the Lawrence Livermore National Laboratory was established to study reconfiguring the NIF to accommodate direct-drive experiments. The present paper is a report to the scientific community, primarily the scientists and engineers working on the design of the NIF. It represents results from work in progress, specifically work completed by the end of the second quarter FY95. This report has two main sections. The first describes the target requirements on the laser drive, and the second part describes how the NIF laser can be configured to accommodate both indirect and direct drive. The report includes a description of the scientific basis for these conclusions. Though a complete picture does not exist, the present understanding is sufficient to conclude that the primary target requirements and laser functional requirements for indirect and direct drive are quite compatible. It is evidently straightforward to reconfigure the NIF to accommodate direct and indirect drive.

31242 (UCRL-ID–121170) **Parametric fits to 1-D neutron transport calculations for lithium-vanadium fusion power plant blankets in cylindrical and spherical geometries.** Petzoldt, R.W.; Perkins, L.J. Lawrence Livermore National Lab., CA (United States). 16 Jun 1995. 14p. Sponsored by USDOE, Washington, DC (United States). DOE Contract W-7405-ENG-48. Order Number DE96001053. Source: OSTI; NTIS; INIS; GPO Dep.

The authors performed 1-D coupled, neutron-gamma transport calculations for lithium-vanadium blankets and lithium-sodium cauldron pot blankets in cylindrical and spherical geometries. Parametric fits to the data are supplied for subsequent use in systems code models. Scaling relationships are given for various neutronics parameters of interest, including: tritium breeding ratio, neutron energy multiplication, magnet dose rates, magnet heating rates, and integrated magnet fluence.

31243 (UCRL-ID–121333) **The origin and evolution of the optics specifications for the National Ignition Facility.** Aikens, D. Lawrence Livermore National Lab., CA (United States). 27 Jun 1995. 12p. Sponsored by USDOE, Washington, DC (United States). DOE Contract W-7405-ENG-48. Order Number DE95017898. Source: OSTI; NTIS; GPO Dep.

In the second half of the 1990's, LLNL and others will be designing and beginning construction of the National Ignition Facility (NIF). At more than 10 times the power and size of the Nova laser system, this new laser will be capable of producing the worlds first controlled fusion ignition and burn, completing a vital milestone on the path to Fusion Energy. In order to optimize the performance of the laser system for a minimum cost, the designers have been conducting a campaign to properly specify the optical properties of the more than 7,500 large optical components to be deployed in the NIF. The draft optics specifications derived from this effort will be presented. The evolution of these specifications, both in language and in content, will be discussed, specifically transmitted wavefront (both P-V and PSD), scratch/dig, surface roughness, bubbles and inclusions specifications.

31244 (UCRL-JC–12065) **A numerical study of shock-acceleration of a diffuse helium cylinder.** Greenough, J.A. (and others); Bell, J.; Colella, P. Lawrence Livermore National Lab., CA (United States). Aug 1995. 6p. Sponsored by USDOE, Washington, DC (United States);Department of Defense, Washington, DC (United States). DOE Contract W-7405-ENG-48. (CONF-9507152–4: 20. international symposium on shock waves, Pasadena, CA (United States), 24-28 Jul 1995). Order Number DE96001317. Source: OSTI; NTIS; INIS; GPO Dep.

The development of a shock-accelerated diffuse Helium cylindrical inhomogeneity is investigated using a new numerical method. The new algorithm is a higher-order Godunov implementation of the so-called multi-fluid equations. This system correctly models multiple component mixtures by accounting for differential compressibility effects. This base integrator is embedded in an implementation of adaptive mesh refinement (AMR) that allows efficient increase in resolution where the computational effort is concentrated where high accuracy, or increased resolution, are required. Qualitative and quantitative comparison with previous experimental data is excellent. The simulations show that countersign vortex blobs are deposited in the jet core by baroclinic generation of the curved shock wave as it traverses the jet. This vorticity deposition occurs over timescales that scale with the shock passage time ($\sim 10\mu$sec). Three phases of development are identified and characterized. The first is the weak deformation (WD) phase, where there is weak distortion of the Helium jet due to weak vorticity induced velocity effects. The second phase is the strong deformation (SD) phase where there is large distortion for the jet and the vortex blobs due to large induced velocity effects. The last is a relaxation/reorganization (RR) phase where the vorticity field reorganizes into point-like vortex pair.

31245 (UCRL-JC–117365) **Conceptual design of the National Ignition Facility.** Paisner, J.A. (Lawrence Livermore National Lab., CA (United States)); Kumpan, S.A.; Lowdermilk, W.H.; Boyes, J.D.; Sorem, M. Lawrence Livermore National Lab., CA (United States). 2 Aug 1995. 13p. Sponsored by USDOE, Washington, DC (United States). DOE Contract W-7405-ENG-48. (CONF-9505264–18: 1. annual solid-state lasers for application to inertial confinement fusion meeting, Monterey, CA (United States), 30 May - 2 jun 1995). Order Number DE96000336. Source: OSTI; NTIS; INIS; GPO Dep.

DOE commissioned a Conceptual Design Report (CDR) for the National Ignition Facility (NIF) in January 1993 as part of a Key Decision Zero (KDO), justification of Mission Need. Motivated by the progress to date by the Inertial Confinement Fusion (ICF) program in meeting the Nova Technical Contract goals established by the National Academy of Sciences in 1989, the Secretary requested a design using a solid-state laser driver operating at the third harmonic (0.35 μm) of neodymium (Nd) glass. The participating ICF laboratories signed a Memorandum of Agreement in August 1993, and established a Project organization, including a technical team from the Lawrence Livermore National Laboratory (LLNL), Los Alamos National Laboratory (LANL), Sandia National Laboratories (SNL), and the Laboratory for Laser Energetics at the University of Rochester. Since then, we completed the NIF conceptual design, based on standard construction at a generic DOE Defense Program's site, and issued a 7,000-page, 27-volume CDR in May 1994.2 Over the course of the conceptual design study, several other key documents were generated, including a Facilities Requirements Document, a Conceptual Design Scope and Plan, a Target Physics Design Document, a Laser Design Cost Basis Document, a Functional Requirements Document, an Experimental Plan for Indirect Drive Ignition, and a Preliminary Hazards Analysis (PHA) Document. DOE used the PHA to categorize the NIF as a low-hazard, non-nuclear facility. On October 21, 1994 the Secretary of Energy issued a Key Decision One (KD1) for the NIF, which approved the Project and authorized DOE to request Office of Management and Budget-approval for congressional line-item FY 1996 NIF funding for preliminary engineering design and for National Environmental Policy Act activities. In addition, the Secretary declared Livermore as the preferred site for constructing the NIF. The Project will cost approximately $1.1 billion and will be completed at the end of FY 2002.

31246 (UCRL-JC–117698-Rev.1) **Contributions of the National Ignition Facility to the development of inertial fusion energy. Revision 1.** Tobin, M. (Lawrence Livermore National Lab., CA (United States)); Logan, G.; Diaz De La Rubia, T.; Schrock, V.; Schultz, K.; Tokheim, R.; Abdou, M.; Bangerter, R. Lawrence Livermore National Lab., CA (United States). Oct 1994. 25p. Sponsored by USDOE, Washington, DC (United States). DOE Contract W-7405-ENG-48. (CONF-940664–37-Rev.1: ISFNT-3: international symposium on fusion nuclear technology, Los Angeles, CA (United States), 27 Jun - 1 jul 1994). Order Number DE95015035. Source: OSTI; NTIS; INIS; GPO Dep.

The Department of Energy is proposing to construct the National Ignition Facility (NIF) to embark on a program to achieve ignition and modest gain in the laboratory early in the next century. The NM will use a $\geq$1.8-MJ, 0.35-mm laser with 192 independent beams, a fifty-fold increase over the energy of the Nova laser. System performance analyses suggest yields as great as 20 MJ may be achievable. NIF will conduct more than 600 shots per year. The

benefits of a micro-fusion capability in the laboratory include: Essential contributions to defense programs, resolution of important Inertial Fusion Energy issues, and unparalleled conditions of energy density for basic science and technology research. We have begun to consider the role the National Ignition Facility will fill in the development of Inertial Fusion Energy. While the achievement of ignition and gain speaks for itself in terms of its impact on developing IFE, we believe there are areas of IFE development, such as fusion power technology, IFE target design and fabrication, and understanding chamber dynamics, that would significantly benefit from NIF experiments. In the area of IFE target physics, ion targets will be designed using the NIF laser, and feasibility of high gain targets will be confirmed. Target chamber dynamics experiments will benefit from x-ray and debris energies that mimic in-IFE-chamber conditions. Fusion power technology will benefit from using single-shot neutron yields to measure spatial distribution of neutron heating, activation, and tritium breeding in relevant materials. IFE target systems will benefit from evaluating low-cost target fabrication techniques by testing such targets on NIF.

31247 (UCRL-JC–117814) **Time-resolved x-ray imaging of high-power laser-irradiated under-dense silica aerogels and agar foams.** Koch, J.A. (and others); Estabrook, K.G.; Bauer, J.D. Lawrence Livermore National Lab., CA (United States). Aug 1995. 50p. Sponsored by USDOE, Washington, DC (United States). DOE Contract W-7405-ENG-48. (CONF-941101–14: Meeting of the Division of Plasma Physics of the American Physical Society, Minneapolis, MN (United States), 7-11 Nov 1994). Order Number DE95017846. Source: OSTI; NTIS; GPO Dep.

This paper presents the results of experiments in which a high-power laser was used to irradiate low density (4 - 9 mg/cm^3) silica aerogel and agar foam targets. The laser-solid interaction and energy transport through the material were monitored with time-resolved imaging diagnostics, and the data show the production and propagation of an x-ray emission front in the plasma. The emission-front trajectory data are found to be in significant disagreement with detailed simulations, which predict a much more rapid heating of the cold material, and the data suggest that this discrepancy is not explainable by target inhomogeneities. Evidence suggests that energy transport into the cold material may be dominated by thermal conduction; however, no completely satisfactory explanation for the discrepancies is identified, and further experimental and theoretical research is necessary in order to resolve this important problem in laser-plasma interaction physics.

31248 (UCRL-JC–118659) **Open-ended magnetic confinement systems for fusion.** Post, R.F.; Ryutov, D.D. Lawrence Livermore National Lab., CA (United States). May 1995. 43p. Sponsored by USDOE, Washington, DC (United States). DOE Contract W-7405-ENG-48. (CONF-9411182–3: 1. international symposium for evaluation of current trends in fusion research, Washington, DC (United States), 14-18 Nov 1994). Order Number DE95016051. Source: OSTI; NTIS; INIS; GPO Dep.

Magnetic confinement systems that use externally generated magnetic fields can be divided topologically into two classes: "closed" and 'open". The tokamak, the stellarator, and the reversed-field-pinch approaches are representatives of the first category, while mirror-based systems and their variants are of the second category. While the recent thrust of magnetic fusion research, with its emphasis on the tokamak, has been concentrated on closed geometry, there are significant reasons for the continued pursuit of research into open-ended systems. The paper discusses these reasons, reviews the history and the present status of open-ended systems, and suggests some future directions for the research.

31249 (UCRL-JC–119019) **The National Ignition Facility front-end laser system.** Burkhart, S.C.; Beach, R.J.; Crane, J.H.; Davin, J.M.; Perry, M.D.; Wilcox, R.B. Lawrence Livermore National Lab., CA (United States). 7 Jul 1995. 13p. Sponsored by USDOE, Washington, DC (United States). DOE Contract W-7405-ENG-48. (CONF-9505264–30: 1. annual solid-state lasers for application to inertial confinement fusion meeting, Monterey, CA (United States), 30 May - 2 jun 1995). Order Number DE96000725. Source: OSTI; NTIS; INIS; GPO Dep.

The proposed National Ignition Facility is a 192 beam Nd:glass laser system capable of driving targets to fusion ignition by the year 2005. A key factor in the flexibility and performance of the laser is a front-end system which provides a precisely formatted beam to each beamline. Each of the injected beams has individually controlled energy, temporal pulseshape, and spatial shape to accommodate beamline-to-beamline variations in gain and saturation. This flexibility also gives target designers the options for precisely controlling the drive to different areas of the target. The design of the Front-End laser is described, and initial results are discussed.

31250 (UCRL-JC–119359) **Transport of a partially-neutralized ion beam in a heavy-ion fusion reactor chamber.** Callahan, D.A.; Langdon, A.B. Lawrence Livermore National Lab., CA (United States). 25 Apr 1995. 5p. Sponsored by USDOE, Washington, DC (United States). DOE Contract W-7405-ENG-48. (CONF-950512–297: Particle accelerator conference, Dallas, TX (United States), 1-5 May 1995). Order Number DE95015420. Source: OSTI; NTIS; INIS; GPO Dep.

In a heavy-ion driven, inertial confinement fusion power plant, a space-charge dominated beam of heavy ions must be transported through a reactor chamber and focused on a 2-3 mm spot at the target. The spot size at the target is determined by the beam emittance and space charge, plus chromatic aberrations in the focusing lens system and errors in aiming the beam. The gain of the ICF capsule depends on the focal spot size. We are investigating low density, nearly-ballistic transport using an electromagnetic, r-z particle-in-cell code. Even at low density ($n \approx 5 \times 10^{13}$ cm^{-3}), beam stripping may be important. To offset the effects of stripping and reduce the space charge, the beam is partially charge neutralized via a pre-formed plasma near the chamber entrance. Additional electrons for charge neutralization come from ionization of the background gas by the beam. Simulations have shown that stripping can greatly increase the spot size; however, partial neutralization can offset most of this increase.

31251 (UCRL-JC–119538) **Progress toward a prototype recirculating induction accelerator for heavy-ion fusion.** Friedman, A. (Lawrence Livermore National Lab., CA (United States)); Barnard, J.J.; Cable, M.D. Lawrence Livermore National Lab., CA (United States); Lawrence Berkeley Lab., CA (United States). 28 Apr 1995. 6p. Sponsored by USDOE, Washington, DC (United States). DOE Contract W-7405-ENG-48 ; AC03-76SF00098. (CONF-950512–332: Particle accelerator conference, Dallas, TX (United States), 1-5 May 1995). Order Number DE96000379. Source: OSTI; NTIS; INIS; GPO Dep.

The US Inertial Fusion Energy (IFE) Program is developing induction accelerator technology toward the goal of electric power production using Heavy-Ion beam-driven inertial Fusion (HIF). The recirculating induction accelerator promises driver cost reduction by repeatedly passing the beam through the same set of accelerating and focusing elements. The authors present plans for and progress, toward a small (4.5-m diameter) prototype recirculator which will accelerate K^+ ions through 15 laps, from 80 to 320 keV and from 2 to 8 mA. Beam confinement is effected via permanent-magnet quadrupoles; bending is via electric dipoles. Scaling laws, and extensive particle and fluid simulations of the space-charge dominated beam behavior, have been used to arrive at the design. An injector and matching section are operational. Initial experiments are investigating intense-beam transport in a linear magnetic channel; near-term plans include studies of transport around a bend. Later experiments will study, insertion/extraction and acceleration with centroid control.

31252 (UCRL-JC–119539) **Development of beam position monitors for heavy ion recirculators.** Deadrick, F.J. (Lawrence Livermore National Lab., CA (United States)); Barnard, J.J.; Fessenden, T.J.; Meridith, J.W.; Rintamaki, J. Lawrence Livermore National Lab., CA (United States). 25 Apr 1995. 4p. Sponsored by USDOE, Washington, DC (United States). DOE Contract W-7405-ENG-48. (CONF-950512–338: Particle accelerator conference, Dallas, TX (United States), 1-5 May 1995). Order Number DE96001319. Source: OSTI; NTIS; INIS; GPO Dep.

Work is underway at the Lawrence Livermore National Laboratory to design and build a small-scale, heavy ion recirculating induction accelerator. An essential part of this design work is the development of small nonintercepting diagnostics to measure beam current and position. This paper describes some of this work, with

particular emphasis on the development of a small capacitive probe beam position monitor to resolve beam position to the 100 μm level in a 6 cm diameter beam pipe. Initial measured results with an 80 keV potassium ion beam are presented.

31253 (UCRL-JC–119579) **Three dimensional simulations of a small induction recirculator accelerator.** Grote, D.P. (Lawrence Livermore National Lab., CA (United States)); Friedman, A.; Haber, I. Lawrence Livermore National Lab., CA (United States). 24 Apr 1995. 4p. Sponsored by USDOE, Washington, DC (United States). DOE Contract W-7405-ENG-48. (CONF-950512–339: Particle accelerator conference, Dallas, TX (United States), 1-5 May 1995). Order Number DE96001318. Source: OSTI; NTIS; INIS; GPO Dep.

A recirculating induction accelerator has potential cost advantages for a heavy-ion fusion driver. In order to explore the physics and technological issues, a small prototype recirculator is being built. The three dimensional particle-in-cell code, WARP3d, is being used in the design and analysis of the experiments. WARP3d is used to examine the behavior of the beam in the electric dipoles and in the non-linear fields associated with the accelerator lattice elements. The dipoles have focusing and fringe fields which can adversely affect the beam quality. Both single particle and full beam dynamics are examined in the dipoles using realistic geometries. Dipole plate designs which minimize the adverse effects are described. The non-linear fields associated with the permanent magnetic quadrupoles have been included in the simulations. They were found to have little effect on the quality of the beam.

31254 (UCRL-JC–119583) **Mechanical design of recirculating accelerator experiments for heavy-ion fusion.** Karpenko, V. Lawrence Livermore National Lab., CA (United States). 23 May 1995. 8p. Sponsored by USDOE, Washington, DC (United States). DOE Contract W-7405-ENG-48. (CONF-950512–331: Particle accelerator conference, Dallas, TX (United States), 1-5 May 1995). Order Number DE95017878. Source: OSTI; NTIS; INIS; GPO Dep.

Recirculating induction accelerators have been studied as a potential low cost driver for inertial fusion energy. At LLNL, we are developing a small (4.5-m diameter), scaled, experimental machine which will demonstrate many of the engineering solutions of a full scale driver. The small recirculator will accelerate singly ionized potassium ions from 80 to 320 keV and 2 to 8 mA, using electric dipoles for bending and permanent magnet quadrupoles for focusing in a compact periodic lattice. *While very compact, and low cost, this design allows the investigation of most of the critical physics issues associated with space-charge-dominated beams in future IFE power plant drivers.* This report describes the recirculator, its mechanical design, its vacuum design, and the process for aligning it. Additionally, a straight magnetic transport experiment is being carried out to test diagnostics and magnetic transport in preparation for the recirculator.

31255 (UCRL-JC–120175) **Precision Nova operations.** Ehrlich, R.B.; Miller, J.L.; Saunders, R.L.; Thompson, C.E.; Weiland, T.L.; Laumann, C.W. Lawrence Livermore National Lab., CA (United States). [1995]. 10p. Sponsored by USDOE, Washington, DC (United States). DOE Contract W-7405-ENG-48. (CONF-9505264–19: 1. annual solid-state lasers for application to inertial confinement fusion meeting, Monterey, CA (United States), 30 May - 2 jun 1995). Order Number DE95017855. Source: OSTI; NTIS; GPO Dep.

To improve the symmetry of x-ray drive on indirectly driven ICF capsules, we have increased the accuracy of operating procedures and diagnostics on the Nova laser. Precision Nova operations includes routine precision power balance to within 10% rms in the "foot" and 5% nns in the peak of shaped pulses, beam synchronization to within 10 ps rms, and pointing of the beams onto targets to within 35 μm rms. We have also added a "fail-safe chirp" system to avoid Stimulated Brillouin Scattering (SBS) in optical components during high energy shots.

31256 (UCRL-JC–120184) **Modeling of microencapsulated polymer shell solidification.** Boone, T. (Soane Technologies, Inc., Hayward, CA (United States)); Cheung, L.; Nelson, D.; Soane, D.; Wilemski, G.; Cook, R. Lawrence Livermore National Lab., CA (United States); Soane Technologies, Inc., Hayward, CA (United States). 8 Mar 1995. 10p. Sponsored by USDOE, Washington, DC (United States). DOE Contract W-7405-ENG-48 ; AC03-91SF18601. (CONF-941144–173: 1994 fall meeting of the Materials Research Society (MRS), Boston, MA (United States), 28 Nov - 2 dec 1994). Order Number DE96000377. Source: OSTI; NTIS; INIS; GPO Dep.

A finite element transport model has been developed and implemented to complement experimental efforts to improve the quality of ICF target shells produced via controlled-mass microencapsulation. The model provides an efficient means to explore the effect of processing variables on the dynamics of shell dimensions, concentricity, and phase behavior. Comparisons with experiments showed that the model successfully predicts the evolution of wall thinning and core/wall density differences. The model was used to efficiently explore and identify initial wall compositions and processing temperatures which resulted in concentricity improvements from 65 to 99%. The evolution of trace amounts of water entering into the shell wall was also tracked in the simulations. Comparisons with phase envelope estimations from modified UNIFAP calculations suggest that the water content trajectory approaches the two-phase region where vacuole formation via microphase separation may occur.

31257 (UCRL-JC–120185) **High efficiency gratings for beam steering on the National Ignition Facility (NIF) laser.** Perry, M.D.; Dixit, S.N.; Shore, B.W.; Boyd, R.D.; Britten, J.A.; Powell, H.T. Lawrence Livermore National Lab., CA (United States). 26 May 1995. 12p. Sponsored by USDOE, Washington, DC (United States). DOE Contract W-7405-ENG-48. (CONF-9505264–3: 1. annual solid-state lasers for application to inertial confinement fusion meeting, Monterey, CA (United States), 30 May - 2 jun 1995). Order Number DE95016630. Source: OSTI; NTIS; GPO Dep.

The design of the National Ignition Facility (NIF) is based on conversion of 1.05 μm wavelength light (1ω) into third harmonic light (3ω) by passage through KDP frequency conversion crystals. It is important for proper coupling of radiation into the targets that the final beam impinging upon the target should have little 1ω or 2ω light. It is also desirable to avoid direct line-of sight for neutrons between the target and the KDP crystals, in order to prevent damage. These issues can be overcome by employing diffraction gratings immediately before the final NIF focusing lens to direct the 3ω beam to the target. A single grating design is highly dispersive, and may introduce intolerable divergence into the beam. In order to overcome this limitation, we propose to use a grating pair. This will provide transverse offset of the beam and eliminate the dispersion while offering several other advantages.

31258 (UCRL-JC–120189) **Diffractive coherence in multilayer dielectric gratings.** Shore, B.W. (Lawrence Livermore National Lab., CA (United States)); Feit, M.D.; Perry, M.D.; Boyd, R.D.; Britten, J.A.; Li, Lifeng. Lawrence Livermore National Lab., CA (United States). 26 May 1995. 15p. Sponsored by USDOE, Washington, DC (United States). DOE Contract W-7405-ENG-48. (CONF-9506238–1: 7. Rochester conference on coherence and quantum optics, Rochester, NY (United States), 7-10 Jun 1995). Order Number DE95016611. Source: OSTI; NTIS; GPO Dep.

Successful operation of large-scale high-power lasers, such as those in use and planned at LLNL and elsewhere, require optical elements that can withstand extremely high fluences without suffering damage. Of particular concern are dielectric diffraction gratings used for beam sampling and pulse compression. Laser induced damage to bulk dielectric material originates with coupling of the electric field of the radiation to bound electrons, proceeding through a succession of mechanisms that couple the electron kinetic energy to lattice energy and ultimately to macroscopic structural changes (e.g. melting). The constructive interference that is responsible for the diffractive behavior of a grating or the reflective properties of a multilayer dielectric stack can enhance the electric field above values that would occur in unstructured homogeneous material. Much work has been done to model damage to bulk matter. The presence of nonuniform electric fields, resulting from diffractive coherence, has the potential to affect damage thresholds and requires more elaborate theory. We shall discuss aspects of work directed towards understanding the influence of dielectric structures upon damage, with particular emphasis on computations and interpretation of electric fields within dielectric gratings and

multilayer dielectric stacks, noting particularly the interference effects that occur in these structures.

31259 (UCRL-JC–120203) **Full aperture laser conditioning of multilayer mirrors and polarizers.** Sheehan, L.; Kozlowski, M.; Tench, B. Lawrence Livermore National Lab., CA (United States). 26 May 1995. 7p. Sponsored by USDOE, Washington, DC (United States). DOE Contract W-7405-ENG-48. (CONF-9505264–6: 1. annual solid-state lasers for application to inertial confinement fusion meeting, Monterey, CA (United States), 30 May - 2 jun 1995). Order Number DE95016628. Source: OSTI; NTIS; GPO Dep.

The Inertial Confinement Fusion (ICF) program at LLNL is beginning the design of a 1.8 Megajoule, 0.35-μm, laser system called the National Ignition Facility (NIF). In order to reduce cost, and increase performance, high damage threshold optics are essential. As a result of damage initiating defects, only a small percentage of current as-deposited optical coatings can meet the required damage threshold specification. Work has been conducted in the area of understanding the causes of these nodular defects and how they are related to laser damage. While it is not yet possible to produce defect-free coatings, it has been found that the damage threshold of some coatings can be increased by as much as 2 or more times as a result of pre-illumination at incrementally increasing fluences. This process, termed laser conditioning, has been associated with the ejection of the damage-initiating defects. With current damage thresholds, mirrors and polarizers for the NIF will have to be laser conditioned in order to meet the laser requirements for fluence propagation. LLNL has constructed a system dedicated to laser conditioning of meter-sized HfO_2/SiO_2 multilayer polarizers and mirrors. The optic is moved in a raster pattern through a stationary 10-Hz rep-rated, 1.064 μm beam with 10-ns pulses. A scatter measurement diagnostic allows on-the-fly evaluation of laser-induced damage during a scan. This system has been used to laser condition optics as large as 73 cm x 37 cm. Such optics are now being used on the Beamlet laser system at LLNL. A description of the conditioning process, its effect on the optic, and an analysis of its application to large areas is presented.

31260 (UCRL-JC–120213) **Neutron and gamma irradiated optical property changes for the final optics of the National Ignition Facility.** Marshall, C.D.; Speth, J.A.; DeLoach, L.D.; Payne, S.A. Lawrence Livermore National Lab., CA (United States). 17 Jul 1995. 6p. Sponsored by USDOE, Washington, DC (United States). DOE Contract W-7405-ENG-48. (CONF-9505264–20: 1. annual solid-state lasers for application to inertial confinement fusion meeting, Monterey, CA (United States), 30 May - 2 jun 1995). Order Number DE96000075. Source: OSTI; NTIS; INIS; GPO Dep.

Based on studies the authors have performed with several radiation sources such as pulsed nuclear reactors, they have been able to construct a physical picture and measure quantitative parameters necessary to model the radiation-induced losses expected for fused silica and fused quartz National Ignition Facility (NIF) target area. It is important to note that these surrogate radiation sources do not have identical temporal and spectral characteristics to NIF, therefore caution is in order since the results obtained to date must be extrapolated somewhat to predict NIF performance.

31261 (UCRL-JC–120220) **Thermal management in inertial fusion energy slab amplifiers.** Sutton, S.B.; Albrecht, G.F. Lawrence Livermore National Lab., CA (United States). 17 Jul 1995. 10p. Sponsored by USDOE, Washington, DC (United States). DOE Contract W-7405-ENG-48. (CONF-9505264–24: 1. annual solid-state lasers for application to inertial confinement fusion meeting, Monterey, CA (United States), 30 May - 2 jun 1995). Order Number DE96000099. Source: OSTI; NTIS; INIS; GPO Dep.

As the technology associated with the development of solid-state drivers for inertial fusion energy (IFE) has evolved, increased emphasis has been placed on the development of an efficient approach for managing the waste heat generated in the laser media. This paper addresses the technical issues associated with the gas cooling of large aperture slabs, where the laser beam propagates through the cooling fluid. It is shown that the major consequence of proper thermal management is the introduction of simple wedge, or beam steering, into the system. Achieving proper thermal management requires careful consideration of the geometry, cooling fluid characteristics, cooling flow characteristics, as well as the thermal/mechanical/optical characteristics of the laser media. Particularly important are the effects of cooling rate variation and turbulent scattering on the system optical performance. Helium is shown to have an overwhelming advantage with respect to turbulent scattering losses. To mitigate cooling rate variations, the authors introduce the concept of flow conditioning. Finally, optical path length variations across the aperture are calculated. A comparison of two laser materials (S-FAP and YAG) shows the benefit of a nearly a-thermal material on optical variations in the system.

31262 (UCRL-JC–120364) **Normal-zone detection in tokamak superconducting magnets with Co- wound voltage sensors.** Martovetsky, N.N.; Chaplin, M.R. Lawrence Livermore National Lab., CA (United States). 8 Jun 1995. 6p. Sponsored by USDOE, Washington, DC (United States). DOE Contract W-7405-ENG-48. (CONF-950691–14: 14. international conference on magnet technology, Tampere (Finland), 11-16 Jun 1995). Order Number DE95014940. Source: OSTI; NTIS; GPO Dep.

This paper discusses advantages and disadvantages of different locations of co-wound voltage sensors for quench detection in tokamak magnets with a cable-in-conduit conductor. The voltage sensor locations are analyzed and estimates of the anticipated noise vs. dB/dt are derived for transverse, parallel, and self fields. The LLNL Noise Rejection Experiment, also described here, is designed to verify theoretical expectations on a copper cable exposed to these fields that will simulate the tokamak field environment.

31263 (UCRL-JC–120520) **Laser chain alignment with low power local light sources.** Bliss, E.S.; Feldman, M.; Murray, J.E.; Vann, C.S. Lawrence Livermore National Lab., CA (United States). 7 Jul 1995. 10p. Sponsored by USDOE, Washington, DC (United States). DOE Contract W-7405-ENG-48. (CONF-9505264–16: 1. annual solid-state lasers for application to inertial confinement fusion meeting, Monterey, CA (United States), 30 May - 2 jun 1995). Order Number DE96000091. Source: OSTI; NTIS; GPO Dep.

Timely and repeatable alignment of the 192 beam National Ignition Facility (NIF) laser will require an automatic system. Demanding accuracy requirements must be met with high reliability at low cost while minimizing the turnaround time between shots. We describe an approach for internally self-consistent alignment of the mirrors in the laser chains using a network of local light sources that serve as near field and far field alignment references. It incorporates a minimum number of alignment lasers, handles many beams in parallel, and utilizes simple control algorithms.

31264 (UCRL-JC–120707) **Low efficiency gratings for 3rd harmonic diagnostics applications.** Britten, J.A.; Boyd, R.D.; Perry, M.D.; Shore, B.W.; Thomas, I.M. Lawrence Livermore National Lab., CA (United States). 9 Aug 1995. 9p. Sponsored by USDOE, Washington, DC (United States). DOE Contract W-7405-ENG-48. (CONF-9505264–15: 1. annual solid-state lasers for application to inertial confinement fusion meeting, Monterey, CA (United States), 30 May - 2 jun 1995). Order Number DE96000339. Source: OSTI; NTIS; INIS; GPO Dep.

The baseline design of the National Ignition Facility (NIF) calls for sampling gratings to provide third-harmonic energy diagnostics in the highly constrained area of the target chamber. These 40 x 40 cm transmission gratings are to diffract at (order +1) nominally 0.3% of the incident 351 run light at a small angle on to a focusing mirror and into a calorimeter. The design calls for a plane grating of 500 lines/mm, and approximately 30 run deep, etched into a fused silica focusing lens and subsequently overcoated with a sol-gel anti reflective coating. Gratings of similar aperture and feature size have been produced for other applications by ion etching processes, but, in an effort to reduce substantially the cost of such optics, we are studying the feasibility of making these gratings by wet chemical etching techniques. Experimentation with high-quality fused silica substrates on 5 and 15 cm. scale has led to a wet etching process which can meet the design goals and which offers no significant scaleup barriers to full sized optics. The grating is produced by holographic exposure and a series of processing steps using only a photoresist mask and a final hydrofluoric acid etch. Gratings on 15 cm diameter test substrates exhibit absolute diffraction efficiencies from 0.2–0.4% with a standard deviation of about 15% of the mean over the full aperture. The efficiency

variation is due to variation in linewidth caused by spatial nonuniformities in exposure energy. Uniformity improvements can be realized by using a smaller, more uniform portion of the exposure beam and exposing for longer times. The laser damage threshold for these gratings has been measured at LLNL and found to be identical to that of the fused silica substrate.

31265 (UCRL-JC–120767) **A database of wavefront measurements for laser system modeling, optical component development and fabrication process qualification.** Wolfe, C.R.; Lawson, J.K.; Aikens, D.M.; English, R.E. Lawrence Livermore National Lab., CA (United States). 12 Apr 1995. 11p. Sponsored by USDOE, Washington, DC (United States). DOE Contract W-7405-ENG-48. (CONF-9507174–1: Interferometry VII applications, Tucson, AZ (United States), 14 Jul 1995). Order Number DE96000386. Source: OSTI; NTIS; INIS; GPO Dep.

In the second half of the 1990's, LLNL and others anticipate designing and beginning construction of the National Ignition Facility (NIF). The NIF will be capable of producing the worlds first laboratory scale fusion ignition and burn reaction by imploding a small target. The NIF will utilize approximately 192 simultaneous laser beams for this purpose. The laser will be capable of producing a shaped energy pulse of at least 1.8 million joules (MJ) with peak power of at least 500 trillion watts (TV). In total, the facility will require more than 7,000 large optical components. The performance of a high power laser of this kind can be seriously degraded by the presence of low amplitude, periodic modulations in the surface and transmitted wavefronts of the optics used. At high peak power, these phase modulations can convert into large intensity modulations by non-linear optical processes. This in turn can lead to loss in energy on target via many well known mechanisms. In some cases laser damage to the optics downstream of the source of the phase modulation can occur. The database described here contains wavefront phase maps of early prototype optical components for the NIF. It has only recently become possible to map the wavefront of these large aperture components with high spatial resolution. Modern large aperture static fringe and phase shifting interferometers equipped with large area solid state detectors have made this possible. In a series of measurements with these instruments, wide spatial bandwidth can be detected in the wavefront.

31266 (UCRL-JC–120780) **Damage and fracture in large aperture, fused silica, vacuum spatial filter lenses.** Campbell, J.H.; Edwards, G.J.; Marion, J.E. Lawrence Livermore National Lab., CA (United States). 7 Jul 1995. 13p. Sponsored by USDOE, Washington, DC (United States). DOE Contract W-7405-ENG-48. (CONF-9505264–21: 1. annual solid-state lasers for application to inertial confinement fusion meeting, Monterey, CA (United States), 30 May - 2 jun 1995). Order Number DE96000076. Source: OSTI; NTIS; INIS; GPO Dep.

Optical damage that results in large scale fracture has been observed in the large, high-fluence, fused-silica, spatial filter lenses on the Nova and Beamlet lasers. In nearly all cases damage occurs on the vacuum side of the lenses and because the vacuum side of the lens is under tensile stress this damage can lead to catastrophic crack growth if the flaw (damage) size exceeds the critical flaw size for SiO_2. The damaged 52 cm Nova lenses fracture into two and sometimes three large pieces. Although under full vacuum load at the time they fracture, the Nova lenses do not implode. Rather the authors have observed that the pieces lock together and air slowly leaks into the vacuum spatial filter housing through the lens cracks. The Beamlet lenses have a larger aspect ratio and peak tensile stress than Nova. The peak tensile stress at the center of the output surface of the Beamlet lens is 1,490 psi versus 810 psi for Nova. During a recent Beamlet high energy shot, a damage spot on the lens grew to the critical flaw size and the lens imploded. Post shot data indicate the lens probably fractured into 5 to 7 pieces, however, unlike Nova, these pieces did not lock together. Analysis shows that the likely source of damage is contamination from pinhole blow-off or out-gassing of volatile materials within the spatial filter. Contamination degrades the antireflection properties of the sol-gel coating and reduces its damage threshold. By changing the design of the Beamlet lens it may be possible to insure that it fails safe by locking up in much that same manner as the Nova lens.

31267 (UCRL-JC–120887) **Can solid-state laser technology serve usefully beyond fusion ignition facilities?** Payne, S.A.; Powell, H.T.; Krupke, W.F. Lawrence Livermore National Lab., CA (United States). 28 Jul 1995. 10p. Sponsored by USDOE, Washington, DC (United States). DOE Contract W-7405-ENG-48. (CONF-9505264–14: 1. annual solid-state lasers for application to inertial confinement fusion meeting, Monterey, CA (United States), 30 May - 2 jun 1995). Order Number DE96000340. Source: OSTI; NTIS; INIS; GPO Dep.

We have explored the major technical and conceptual issues relating to the suitability of a diode-pumped solid state laser as a driver for an inertial fusion energy power plant. While solid state lasers have long served as the workhorse of inertial confinement fusion physics studies, the deployment of a driver possessing adequate efficiency, reliability, and repetition rate for inertial fusion energy requires the implementation of several technical innovations discussed in this article.

31268 (UCRL-JC–121125) **Parasitic pencil beams caused by lens reflections in laser amplifier chains.** Murray, J.E. (and others); Van Wonterghem, B.; Seppala, L. Lawrence Livermore National Lab., CA (United States). 7 Jul 1995. 8p. Sponsored by USDOE, Washington, DC (United States). DOE Contract W-7405-ENG-48. (CONF-9505264–17: 1. annual solid-state lasers for application to inertial confinement fusion meeting, Monterey, CA (United States), 30 May - 2 jun 1995). Order Number DE96000092. Source: OSTI; NTIS; GPO Dep.

Reflections from lens surfaces create parasitic beams that can damage optics in high-powered laser systems. These parasitic beams are low in energy initially, because of the low reflectivity of antireflection (AR) coated lens surfaces and because they are clipped by spatial filter pinholes, but subsequent amplification can raise them to damage fluence levels. Also, some of the pencil beams in multipass laser systems become pre-pulses at the output by by-pass one of more of the passes, arriving at the output ahead of the main pulse in time. They are insidious because pencil beams that are not initially a problem can become so due to a slow degradation of the AR coatings. Both the Nova and Beamlet laser systems at LLNL have had optics damaged by pencil beams. The best solution for pencil beams is to tip the lenses far enough to eliminate them altogether. This will be the approach taken for the National Ignition Facility (NIF).

31269 (UCRL-JC–121127) **Continuous contour phase plates for tailoring the focal plane irradiance profile.** Dixit, S.N.; Rushford, M.C.; Thomas, I.M.; Perry, M.D. Lawrence Livermore National Lab., CA (United States). 9 Aug 1995. 11p. Sponsored by USDOE, Washington, DC (United States). DOE Contract W-7405-ENG-48. (CONF-9505264–13: 1. annual solid-state lasers for application to inertial confinement fusion meeting, Monterey, CA (United States), 30 May - 2 jun 1995). Order Number DE96000341. Source: OSTI; NTIS; INIS; GPO Dep.

We present fully continuous phase screens for producing super-Gaussian focal-plane irradiance profiles. Such phase screens are constructed with the assumption of either circular symmetric near-field and far-field profiles or a separable phase screen in Cartesian co-ordinates. In each case, the phase screen is only a few waves deep. Under illumination by coherent light, such phase screens produce high order super-Gaussian profiles in the focal plane with high energy content effects of beam aberrations on the focal profiles and their energy content are also discussed.

31270 (UCRL-JC–121128) **Electric field enhancement in metallic and multilayer dielectric gratings.** Shore, B.W. (Lawrence Livermore National Lab., CA (United States)); Feit, M.D.; Perry, M.D.; Boyd, R.D.; Britten, J.A.; Li, Lifeng. Lawrence Livermore National Lab., CA (United States). 26 May 1995. 7p. Sponsored by USDOE, Washington, DC (United States). DOE Contract W-7405-ENG-48. (CONF-9505264–4: 1. annual solid-state lasers for application to inertial confinement fusion meeting, Monterey, CA (United States), 30 May - 2 jun 1995). Order Number DE95016608. Source: OSTI; NTIS; INIS; GPO Dep.

Successful operation of large-scale high-power lasers, such as those in use and planned at LLNL and elsewhere, require optical elements that can withstand extremely high fluences without suffering damage. Of particular concern are gratings used for pulse

compression. Laser induced damage to bulk dielectric material originates with coupling of the electric field of the radiation to bound electrons, proceeding through a succession of mechanisms that couple the electron kinetic energy to lattice energy and ultimately to macroscopic structural changes (e.g. fracture, melting, ablation, etc.). The constructive interference that is responsible for the diffractive behavior of a grating or the reflective properties of a multilayer dielectric stack can enhance the electric field above values that would occur in unstructured homogeneous material. The presence of nonuniform electric fields, resulting from diffractive coherence, has the potential to affect damage thresholds We describe aspects of LLNL work directed towards understanding the influence of dielectric structures upon damage, with particular emphasis on electric fields within multilayer dielectric stacks.

31271 (UCRL-JC–121148) **The measurement and analysis of wavefront structure from large aperture ICF optics.** Wolfe, C.R.; Lawson, J.K. Lawrence Livermore National Lab., CA (United States). 30 May 1995. 25p. Sponsored by USDOE, Washington, DC (United States). DOE Contract W-7405-ENG-48. (CONF-9505264–2: 1. annual solid-state lasers for application to inertial confinement fusion meeting, Monterey, CA (United States), 30 May - 2 jun 1995). Order Number DE95016609. Source: OSTI; NTIS; INIS; GPO Dep.

This paper discusses the techniques, developed over the past year, for high spatial resolution measurement and analysis of the transmitted and/or reflected wavefront of large aperture ICF optical components. Parts up to 400 mm x 750 mm have been measured and include: laser slabs, windows, KDP crystals and lenses. The measurements were performed using state-of-the-art commercial phase shifting interferometers at a wavelength of 633 μm. Both 1 and 2-D Fourier analysis have been used to characterize the wavefront; specifically the Power Spectral Density, (PSD), function was calculated. The PSDs of several precision optical components will be shown. The PSD(V) is proportional to the (amplitude)^2 of components of the Fourier frequency spectrum. The PSD describes the scattered intensity and direction as a function of scattering angle in the wavefront. The capability of commercial software is limited to 1-D Fourier analysis only. We are developing our own 2-D analysis capability in support of work to revise specifications for NIF optics. 2-D analysis uses the entire wavefront phase map to construct 2D PSD functions. We have been able to increase the signal-to-noise relative to 1-D and can observe very subtle wavefront structure.

31272 (UCRL-JC–121180) **Plasma electrode pockels cell for ICF lasers.** Rhodes, M.A.; Boley, C.D.; Tarditi, A.G.; Bauer, B.S. Lawrence Livermore National Lab., CA (United States). 7 Jul 1995. 14p. Sponsored by USDOE, Washington, DC (United States). DOE Contract W-7405-ENG-48. (CONF-9505264–22: 1. annual solid-state lasers for application to inertial confinement fusion meeting, Monterey, CA (United States), 30 May - 2 jun 1995). Order Number DE96000726. Source: OSTI; NTIS; INIS; GPO Dep.

In a plasma-electrode Pockels cell (PEPC), plasma discharges serve as transparent electrodes on each side of, an electrooptic crystal such as KDP. These plasmas facilitate rapid and uniform charging and discharging of the crystal. The authors describe PEPC technology deployed on Beamlet and envisioned for the National Ignition Facility. Performance on Beamlet is discussed in detail. They also discuss models which have shed light on PEPC operation. These models describe both the high-voltage sheath that forms near the crystal surface and the characteristics of the bulk plasma column.

31273 (UCRL-JC–121195) **Illumination uniformity requirements for direct drive inertial confinement fusion.** Rothenberg, J.E.; Eimerl, D.; Key, M.H.; Weber, S.V. Lawrence Livermore National Lab., CA (United States). 11 Jul 1995. 12p. Sponsored by USDOE, Washington, DC (United States). DOE Contract W-7405-ENG-48. (CONF-9505264–23: 1. annual solid-state lasers for application to inertial confinement fusion meeting, Monterey, CA (United States), 30 May - 2 jun 1995). Order Number DE96000074. Source: OSTI; NTIS; INIS; GPO Dep.

The requirements for laser uniformity are discussed in terms of the ℓ-mode spectrum. It is shown that the choice of smoothing methods can significantly alter this spectrum and that this choice should be made in the context of the target physics. Although two dimensional smoothing by spectral dispersion yields a high quality near field beam profile, it results in poor smoothing for low spatial frequency. The partially coherent light method (fiber smoothing) leads to superior smoothing at low spatial frequencies, but has very poor near field beam quality. As a result, it may be desirable to use partially coherent light during the driver pulse foot (at low intensity and when minimizing the laser imprint is critical) and smoothing by spectral dispersion during the main pulse.

31274 (UCRL-JC–121198) **Two dimensional beam smoothing by spectral dispersion for direct drive inertial confinement fusion.** Rothenberg, J.E. Lawrence Livermore National Lab., CA (United States). 11 Jul 1995. 15p. Sponsored by USDOE, Washington, DC (United States). DOE Contract W-7405-ENG-48. (CONF-9505264–26: 1. annual solid-state lasers for application to inertial confinement fusion meeting, Monterey, CA (United States), 30 May - 2 jun 1995). Order Number DE96000093. Source: OSTI; NTIS; INIS; GPO Dep.

Two dimensional smoothing by spectral dispersion is analyzed by using diffraction theory calculations. It is shown that by using standard frequency modulated light one can obtain bandwidth limited smoothing over integration times relevant to inertial confinement fusion (about 1 nsec) with modest induced beam divergence. At longer integration times one can obtain bandwidth limited smoothing by increasing the divergence and/or by using more advanced phase modulation methods.

31275 (UCRL-JC–121271) **Configuring NIF for direct drive experiments.** Eimerl, D. (and others); Rothenberg, J.; Key, M. Lawrence Livermore National Lab., CA (United States). 11 Jul 1995. 11p. Sponsored by USDOE, Washington, DC (United States). DOE Contract W-7405-ENG-48. (CONF-9505264–27: 1. annual solid-state lasers for application to inertial confinement fusion meeting, Monterey, CA (United States), 30 May - 2 jun 1995). Order Number DE96000094. Source: OSTI; NTIS; INIS; GPO Dep.

The National Ignition Facility (NIF) is a proposed 1.8 MJ laser facility for carrying out experiments in inertial confinement fusion, currently designed for indirect drive experiments. The direct drive approach is being pursued at the 30 kJ Omega facility at the University of Rochester. In this paper we discuss the modifications to the NIF laser that would be required for both indirect and direct drive experiments. A primary concern is the additional cost of adding direct drive capability to the facility.

31276 (UCRL-JC–121281) **Effects of space charge in beams for heavy ion fusion.** Sharp, W.M.; Friedman, A.; Grote, D.P. Lawrence Livermore National Lab., CA (United States). 1 Sep 1995. 11p. Sponsored by USDOE, Washington, DC (United States). DOE Contract W-7405-ENG-48. (CONF-9509149–2: International symposium on heavy ion inertial fusion, Princeton, NJ (United States), 6-9 Sep 1995). Order Number DE96000753. Source: OSTI; NTIS; INIS; GPO Dep.

A new analytic model is presented that accurately estimates the radially averaged axial component of the space-charge field of an axisymmetric heavy-ion beam in a cylindrical beam pipe. The model recovers details of the field near the beam ends that are overlooked by simpler models, and the results compare well to exact solutions of Poisson's equation. Field values are shown for several simple beam profiles and are compared with values obtained from simpler models. The model has been implemented in the fluid/envelope code CIRCE and used to study longitudinal confinement in beams with a variety of axial profiles. The effects of errors in the longitudinal-control fields are presented.

31277 (UCRL-JC–121286) **Angular biasing in implicit Monte-Carlo.** Zimmerman, G.B. Lawrence Livermore National Lab., CA (United States). 20 Oct 1994. 6p. Sponsored by USDOE, Washington, DC (United States). DOE Contract W-7405-ENG-48. (CONF-9410254–9: Nuclear explosives code developers conference (NECDC), Las Vegas, NV (United States), 27 Oct 1994). Order Number DE95017862. Source: OSTI; NTIS; INIS; GPO Dep.

Calculations of indirect drive Inertial Confinement Fusion target experiments require an integrated approach in which laser irradiation and radiation transport in the hohlraum are solved simultaneously with the symmetry, implosion and burn of the fuel

capsule. The Implicit Monte Carlo method has proved to be a valuable tool for the two dimensional radiation transport within the hohlraum, but the impact of statistical noise on the symmetric implosion of the small fuel capsule is difficult to overcome. We present an angular biasing technique in which an increased number of low weight photons are directed at the imploding capsule. For typical parameters this reduces the required computer time for an integrated calculation by a factor of 10. An additional factor of 5 can also be achieved by directing even smaller weight photons at the polar regions of the capsule where small mass zones are most sensitive to statistical noise.

31278 (UCRL-JC–121452) **Perturbation theory for frequency doubling and tripling of electric field amplitude and phase ripples.** Auerbach, J.M. (Lawrence Livermore National Lab., CA (United States)); Eimerl, D.; Hunt, J.T.; Milam, D.; Trenholme, J.B.; Milonni, P.W. Lawrence Livermore National Lab., CA (United States). 27 Jun 1995. 8p. Sponsored by USDOE, Washington, DC (United States). DOE Contract W-7405-ENG-48. (CONF-9505264–11: 1. annual solid-state lasers for application to inertial confinement fusion meeting, Monterey, CA (United States), 30 May - 2 jun 1995). Order Number DE95015984. Source: OSTI; NTIS; INIS; GPO Dep.

A perturbation theory has been developed to calculate the transfer of electric field amplitude and phase ripples from the first harmonic to either the second harmonic or the third harmonic. The theory is restricted to steady-state conversion processes. In the case of small phase gradients, the real and imaginary parts of the output harmonic ripple are related to the real and imaginary parts of the input perturbation by a 2 × 2 matrix. To confirm the validity of the perturbation theory, we have performed an initial set of experiments on the Optical Sciences Laser to investigate the transfer of a weak ripple from the first harmonic to the second harmonic.

31279 (UCRL-JC–121456) **Engineering development for a small-scale recirculator experiment.** Newton, M.A. (Lawrence Livermore National Lab., CA (United States)); Deadrick, F.J.; Hanks, R.L.; Hawkins, S.A.; Holm, K.A.; Kirbie, H.C.; Karpenko, V.P.; Nattrass, L.A.; Longinotti, D.B. Lawrence Livermore National Lab., CA (United States). 4 Sep 1995. 9p. Sponsored by USDOE, Washington, DC (United States). DOE Contract W-7405-ENG-48. (CONF-9509149–1: International symposium on heavy ion inertial fusion, Princeton, NJ (United States), 6-9 Sep 1995). Order Number DE96000754. Source: OSTI; NTIS; INIS; GPO Dep.

Lawrence Livermore National Laboratory (LLNL) is evaluating the physics and technology of recirculating induction accelerators for heavy-ion inertial-fusion drivers. As part of this evaluation, the authors are building a small-scale recirculator to demonstrate the concept and to use as a test bed for the development of recirculator technologies. System designs have been completed and components are presently being designed and developed for the small-scale recirculator. This paper discusses results of the design and development activities that are presently being conducted to implement the small-scale recirculator experiments. An, overview of the system design is presented along with a discussion of the implications of this design on the mechanical and electrical hardware. The paper focuses primarily on discussions of the development and design of the half-lattice period hardware and the advanced solid-state modulator.

31280 (UCRL-JC–121585) **The physics of radiation driven ICF hohlraums.** Rosen, M.D. Lawrence Livermore National Lab., CA (United States). 7 Aug 1995. 21p. Sponsored by USDOE, Washington, DC (United States). DOE Contract W-7405-ENG-48. (CONF-9508164–1: Plasma physics and technology conference, La Jolla, CA (United States), 8-18 Aug 1995). Order Number DE96000344. Source: OSTI; NTIS; INIS; GPO Dep.

On the Nova Laser at LLNL, we have recently demonstrated many of the key elements required for assuring that the next proposed laser, the National Ignition Facility (NIF) will drive an Inertial Confinement Fusion (ICF) target to ignition. The target uses the recently declassified indirect drive (sometimes referred to as "radiation drive") approach which converts laser light to x-rays inside a gold cylinder, which then acts as an x-ray "oven" (called a hohlraum) to drive the fusion capsule in its center. On Nova we've demonstrated good understanding of the temperatures reached in hohlraums and of the ways to control the uniformity with which the x-rays drive the spherical fusion capsules. In this lecture we briefly review the fundamentals of ICF, and describe the capsule implosion symmetry advantages of the hohlraum approach. We then concentrate on a quantitative understanding of the scaling of radiation drive with hohlraum size and wall material, and with laser pulse length and power. We demonstrate that coupling efficiency of x-ray drive to the capsule increases as we proceed from Nova to the NIF and eventually to a reactor, thus increasing the gain of the system.

31281 (UCRL-JC–121586) **Measurement by XUV laser radiography of hydrodynamic perturbations in laser accelerated thin foil targets.** Key, M.H. (Lawrence Livermore National Lab., CA (United States)); Kalantar, D.H.; Barbee, T.W. Jr. Lawrence Livermore National Lab., CA (United States). 11 Jul 1995. 12p. Sponsored by USDOE, Washington, DC (United States). DOE Contract W-7405-ENG-48. (CONF-950793–20: 40. annual meeting of the Society of Photo-Optical Instrumentation Engineers, San Diego, CA (United States), 9-14 Jul 1995). Order Number DE95016632. Source: OSTI; NTIS; INIS; GPO Dep.

A novel diagnostic application of XUV lasers has been developed for the study of the hydrodynamic imprinting of laser speckle pattern on directly driven laser fusion targets. A neon-like Yttrium laser operating at 15.5 nm is used to probe thin foils of Si irradiated with an SSD smoothed laser at 0.35 mm wavelength and 6 10^{12} Wcm^{-2} intensity, simulating the initial phase of irradiation a laser fusion capsule. Measurements of the perturbations in target opacity are made by XUV radiography through the foil. The magnitude and Fourier composition of the perturbations has been determined both before and after Rayleigh Taylor growth showing the mode spectra of both the initial imprint and the subsequent RT growth.

31282 (UCRL-JC–121624) **Collisionless absorption of light waves incident on overdense plasmas with steep density gradients.** Yang, T.Y.B.; Kruer, W.L.; Langdon, A.B. Lawrence Livermore National Lab., CA (United States). 31 Jul 1995. 10p. Sponsored by USDOE, Washington, DC (United States). DOE Contract W-7405-ENG-48. (CONF-9508164–2: Plasma physics and technology conference, La Jolla, CA (United States), 8-18 Aug 1995). Order Number DE95017872. Source: OSTI; NTIS; INIS; GPO Dep.

Collisionless absorption of laser light incident on overdense plasmas with steep density gradients is studied analytically and numerically. For the normal incidence case, it is shown that both sheath inverse bremsstrahlung and the anomalous skin effect are limiting cases of the same collisionless absorption mechanism. Using particle-in-cell (PIC) plasma simulations, the effects of finite sheath-transit time and finite density gradient are investigated. The analyses are extended to oblique incident cases. For p-polarized obliquely incident light, the results are significantly different from those for the normal incidence case. Most noticeable is the absorption enhancement for the p-polarized light due to the interaction of the electrons with the normal (parallel to the density gradient) component of the laser electric field in the sheath region.

31283 (UCRL-JC–121652) **Optical scatter as a diagnostic tool for studying bulk defects which cause laser damage in conventional and rapid growth KP and DKDP.** Woods, B. (and others); Runkel, M.; Yan, M. Lawrence Livermore National Lab., CA (United States). 10 Jul 1995. 8p. Sponsored by USDOE, Washington, DC (United States). DOE Contract W-7405-ENG-48. (CONF-950793–38: 40. annual meeting of the Society of Photo-Optical Instrumentation Engineers, San Diego, CA (United States), 9-14 Jul 1995). Order Number DE95017821. Source: OSTI; NTIS; GPO Dep.

Single crystals of KH_2PO_4 (KDP) and $(D_xH_{1-x})_2PO_4$ (DKDP) will be used for frequency conversion and as part of a large aperture optical switch in the proposed National Ignition Facility (NIF) at the Lawrence Livermore National Laboratory (LLNL). These crystals must have good optical properties and high laser damage thresholds. Currently these crystals have a lower laser damage threshold than other optical materials in the laser chain which has forced designers to limit the output fluence of the NIF in order to avoid damaging the crystals. Furthermore, while more efficient frequency conversion schemes are being explored both theoretically and experimentally, the advantages of these schemes can not be fully

realized unless the damage thresholds of the conversion crystals are increased. Over the past decade, LLNL has generated an extensive data base on the laser damage in KDP and DKDP crystals both at the first and third harmonics of Nd-YAG. While the damage thresholds of these crystals have increased over this time period due, in part, to better filtration of the growth solution, the damage thresholds of the best crystals are still far below what is expected from theoretical limits calculated from the band structure of perfect crystals. Thus damage in KDP and DKDP is caused by defects in the crystals. The authors also rely on a process called laser conditioning to improve the damage thresholds of the crystals. Unfortunately, little is understood about the mechanism of laser induced damage, the conditioning process in the crystals, or the defects which are responsible for damage. The authors have recently implemented a scatter diagnostic for locating and studying defects in crystals and as a tool for studying the mechanism of laser damage and laser conditioning.

31284 (UCRL-JC–121817) **Fault tolerance of the NIF power conditioning system.** Larson, D.W. (Lawrence Livermore National Lab., CA (United States)); Anderson, R.; Boyes, J. Lawrence Livermore National Lab., CA (United States). 7 Jul 1995. 10p. Sponsored by USDOE, Washington, DC (United States). DOE Contract W-7405-ENG-48. (CONF-9505264–29: 1. annual solid-state lasers for application to inertial confinement fusion meeting, Monterey, CA (United States), 30 May - 2 jun 1995). Order Number DE96000751. Source: OSTI; NTIS; INIS; GPO Dep.

The tolerance of the circuit topology proposed for the National Ignition Facility (NIF) power conditioning system to specific fault conditions is investigated. A new pulsed power circuit is proposed for the NIF which is simpler and less expensive than previous ICF systems. The inherent fault modes of the new circuit are different from the conventional approach, and must be understood to ensure adequate NIF system reliability. A test-bed which simulates the NIF capacitor module design was constructed to study the circuit design. Measurements from test-bed experiments with induced faults are compared with results from a detailed circuit model. The model is validated by the measurements and used to predict the behavior of the actual NIF module during faults. The model can be used to optimize fault tolerance of the NIF module through an appropriate distribution of circuit inductance and resistance. The experimental and modeling results are presented, and fault performance is compared with the ratings of pulsed power components. Areas are identified which require additional investigation.

31285 (UCRL-LR–119363) **Three dimensional simulations of space charge dominated heavy ion beams with applications to inertial fusion energy.** Grote, D.P. Lawrence Livermore National Lab., CA (United States). 1 Nov 1994. 129p. Sponsored by USDOE, Washington, DC (United States). DOE Contract W-7405-ENG-48. Order Number DE96000393. Source: OSTI; NTIS; INIS; GPO Dep.

Heavy ion fusion requires injection, transport and acceleration of high current beams. Detailed simulation of such beams requires fully self-consistent space charge fields and three dimensions. WARP3D, developed for this purpose, is a particle-in-cell plasma simulation code optimized to work within the framework of an accelerator's lattice of accelerating, focusing, and bending elements. The code has been used to study several test problems and for simulations and design of experiments. Two applications are drift compression experiments on the MBE-4 facility at LBL and design of the electrostatic quadrupole injector for the proposed ILSE facility. With aggressive drift compression on MBE-4, anomalous emittance growth was observed. Simulations carried out to examine possible causes showed that essentially all the emittance growth is result of external forces on the beam and not of internal beam space-charge fields. Dominant external forces are the dodecapole component of focusing fields, the image forces on the surrounding pipe and conductors, and the octopole fields that result from the structure of the quadrupole focusing elements. Goal of the design of the electrostatic quadrupole injector is to produce a beam of as low emittance as possible. The simulations show that the dominant effects that increase the emittance are the nonlinear octopole fields and the energy effect (fields in the axial direction that are off-axis). Injectors were designed that minimized the beam envelope in order to reduce the effect of the nonlinear fields. Alterations to the quadrupole structure that reduce the nonlinear fields further were examined. Comparisons were done with a scaled experiment resulted in very good agreement.

31286 (UCRL-PROP–117093-Vol.1) **National Ignition Facility conceptual design report (192 beam): Volume 1, Summary.** Lawrence Livermore National Lab., CA (United States). May 1994. 60p. Sponsored by USDOE, Washington, DC (United States). (NIF-LLNL–94-113-Vol.1). Order Number DE95017677. Source: OSTI; NTIS (US Sales Only); GPO Dep.

The goal of the National Ignition Facility (NIF) project is to provide an aboveground experimental capability for maintaining nuclear competence and weapons effects simulation, and to provide a facility that is capable of achieving fusion ignition utilizing solid-state lasers as the energy driver. In this facility, a large number of laser beams will be focused onto a small target located at the center of a spherical target chamber; the energy from the laser beams will be deposited in a few billionths of a second. The target will then implode, forcing atomic nuclei to sufficiently high temperatures and density necessary to achieve a miniature fusion reaction. The NIF project proposes to construct a facility to accomplish this goal. The NIF Conceptual Design Report (CDR) was prepared by a multi-laboratory team within the Inertial Confinement Fusion (ICF) Program to support the request for line-item funding for the NIF project. The Project is defined by a number of Work Breakdown Structure (WBS) elements, which include: Project Office (WBS 1.1); Conventional Facilities (WBS 1.2); Laser System (WBS 1.3); Target Area (WBS 1.4); Integrated Computer Control Systems (WBS 1.5); Optical Components (WBS 1.6); Start-up Activities (WBS 1.10); ES&H/Supporting R&D (WBS 1.11); The first six elements of the WBS represent plant and capital equipment (PACE) costs and the last two represent other project costs (OPC). The NIF CDR consists of 10 chapters and six appendices.

99 GENERAL AND MISCELLANEOUS

Refer also to citation(s) 30542, 30543, 30544, 31399

31287 (CONF-9411250–1) **Future generations, environmental ethics, and global environmental change.** Tonn, B.E. Oak Ridge National Lab., TN (United States). [1994]. 19p. Sponsored by USDOE, Washington, DC (United States). DOE Contract AC05-84OR21400. From 1. international future generations forum; Kyoto (Japan); 23-25 Nov 1994. Order Number DE95014029. Source: OSTI; NTIS; GPO Dep.

The elements of a methodology to be employed by the global community to investigate the consequences of global environmental change upon future generations and global ecosystems are outlined in this paper. The methodology is comprised of two major components: A possible future worlds model; and a formal, citizen-oriented process to judge whether the possible future worlds potentially inheritable by future generations meet obligational standards. A broad array of descriptors of future worlds can be encompassed within this framework, including survival of ecosystems and other species and satisfaction of human concerns. The methodology expresses fundamental psychological motivations and human myths journey, renewal, mother earth, and being-in-nature-and incorporates several viewpoints on obligations to future generations-maintaining options, fairness, humility, and the cause of humanity. The methodology overcomes several severe drawbacks of the economic-based methods most commonly used for global environmental policy analysis.

31288 (DOE/ER–0660T) **Advanced energy projects; FY 1995 research summaries.** USDOE Office of Energy Research, Washington, DC (United States). Advanced Energy Projects Div. Sep 1995. 51p. Sponsored by USDOE, Washington, DC (United States). Order Number DE96001128. Source: OSTI; NTIS; GPO Dep.

The AEP Division supports projects to explore novel energy-related concepts which are typically at an early stage of scientific development, and high-risk, exploratory concepts. Topical areas presently receiving support are: novel materials for energy technology, renewable and biodegradable materials, exploring uses of

new scientific discoveries, alternate pathways to energy efficiency, alternative energy sources, and innovative approaches to waste treatment and reduction. There were 46 research projects during FY 1995; ten were initiated during that fiscal year. The summaries are separated into grant and laboratory programs, and small business innovation research programs.

31289 (KRC–91A-J03) **Research on the performance Characteristics of Electronic Communication Equipment to Radiated Electromagnetic Field Disturbance.** Ham, K.C. (Korea Electric Power Corp. (KEPCO), Taejon (Korea, Republic of). Research Center); Park, S.E.; Kang, Y.S.; Moo, H.S.; Choi, H.Y.; Lee, K.C.; Park, B.R.; Ko, Y.; Kim, S.J.; Kim, N.C.; Lee, J.B.; Har, T.H.; Chung, J.Y. Korea Electric Power Corp. (KEPCO), Taejon (Korea, Republic of). Research Center. 1994. 228p. (In Korean). Order Number DE96703570. Source: OSTI; NTIS (US Sales Only).

Most of modern power system operating and control equipments make use of microelectronics technology. Though these digital equipments have much advantage over the conventional analog tools, they have a weak point that are very sensitive to external electromagnetic environment. Therefore when a new equipment is introduced, we must consider the possibility of mutual interferences between the new equipments and existing ones. And sufficient investigations about the noise immunity of the equipment to neighboring environment should be made. Under the above motivation, KEPCO and KERI carried out a joint project [A] Study on the EMI Effects upon Electronic Appliance Facilities in Substation for two years, and this project is succeeding one. The object of this study is the investigation of radiated noise immunity of electronic communication equipments that use digital and microprocessor technologies, and examination of relation between the applied noise frequency and misoperations of equipments, and the evaluation of CRT effect against extremely low frequency magnetic field. (author). figs.

31290 (KRC–91A-J04) **A Study on Management Techniques of Power Telecommunication System by Reliability Analysis.** Lee, B.K. (Korea Electric Power Corp. (KEPCO), Taejon (Korea, Republic of). Research Center); Lee, B.S.; Woy, Y.H.; Oh, M.T.; Shin, M.T.; Kwan, O.G.; Kim, K.H.; Kim, Y.H.; Lee, W.T.; Park, Y.H.; Lee, J.J.; Park, H.S.; Choi, M.C.; Kim, J. Korea Electric Power Corp. (KEPCO), Taejon (Korea, Republic of). Research Center. 1994. 195p. (In Korean). Order Number DE96703569. Source: OSTI; NTIS (US Sales Only).

Power telecommunication network is being increased rapidly in that expansion of power facilities according to the growth of electric power supply. The requirement of power facility and office automation and importance of communication services make it to complex and confusing to operate. And, for the sake of correspond to the change of power telecommunication network, effective operation and management is called for urgently. Therefore, the object of this study is to establish total reliability analysis system based on dependability, maintainability, cost effectiveness and replenishment for keep up reasonable reliability, support economical maintenance and reasonable planning of facility investment. And it will make effective management and administration system and schemes for total reliability improvement. (author). 44 refs., figs.

31291 (KRC–91A-J05) **A Study for development and Application of Hangulization in SCADA System.** Namm, K.C. (Korea Electric Power Corp. (KEPCO), Taejon (Korea, Republic of). Research Center); Woo, H.K.; Moon, H.S.; Choi, S.S.; Cho, S.K.; Lee, M.G.; Lee, Y.S.; Lee, K.S.; Chung, Y.B.; Lee, H.I.; Wang, B.H.; Chung, J.K.; Hwang, M.S.; Ann, H.S.; Park, J.KKorea Electric Power Corp. (KEPCO), Taejon (Korea, Republic of). Research Center. 1994. 322p. (In Korean). Order Number DE96703561. Source: OSTI; NTIS (US Sales Only).

[M]9200 SCADA system is being operated for power system control and data acquisition at somedistricts in korea, but all texts are displayed in English, so the operators have difficulty in easy reading and making decision. The purpose of this study is to change the english characters on CRT into the Korean characters. As the result, misunderstanding of power dispatching status will be excluded and system operation efficiency of power dispatching will be improved. In this study, we studied and analyzed hardware and software of M9200 SCADA system, and we developed programs which can be change in korean alphabet display on the peripheral devices of the M9200 SCADA system. (author). 57 refs., figs.

31292 (KRC–91A-S01) **A Study on the Asynchronous Interconnection Technology Between IBM Host and OA Equipment.** Woo, H.K. (Korea Electric Power Corp. (KEPCO), Taejon (Korea, Republic of). Research Center); Lee, K.J.; Han, M.S.; Lee, B.K.; Cho, H.G.; Kang, S.C.; Chung, C.M. Korea Electric Power Corp. (KEPCO), Taejon (Korea, Republic of). Research Center. 1993. 237p. (In Korean). Order Number DE96703560. Source: OSTI; NTIS (US Sales Only).

The N5200 word processor could contact to the IBM host only by PT3270KS card and emulation software, which is needed by each machine and it exchanges the data with only synchronous transmitting method. So existing method shows high connecting cost and low line efficiency. For reducing this networking cost and for promoting line efficiency, this study makes a research into protocol conversion which gets users to use of OA devices freely as a asynchronous or synchronous terminal and which makes the data exchange easy. (author). 10 refs., figs.

31293 (KRC–92A-S06) **The Study on Standardization of LAN System for KEPCO.** Chung, C.M. (Korea Electric Power Corp. (KEPCO), Taejon (Korea, Republic of). Research Center); Woo, H.K.; Kim, J.H. Korea Electric Power Corp. (KEPCO), Taejon (Korea, Republic of). Research Center. 1994. 267p. (In Korean). Order Number DE96703566. Source: OSTI; NTIS (US Sales Only).

It is necessary to have an individual information and communication network in order to process the power information of many branch offices located throughout the whole country automatically, and nowadays many branch offices are setting up the individual LAN system. But the complexity and variety of computers and network devices can cause a few difficulties to the interconnection and interoperation among those. In this paper, we proposed some standard forms for KEPCO LAN system. (author). 25 refs., figs.

31294 (KRC–93A-T08) **A Technology Study of Wireless LAN for Power Utility Application.** Nam, K.C. (Korea Electric Power Corp. (KEPCO), Taejon (Korea, Republic of). Research Center); Lee, B.K.; Woy, Y.H.; Ku, Y.K.; Kim, J.B.; Park, D.W.; Chung, H.B. Korea Electric Power Corp. (KEPCO), Taejon (Korea, Republic of). Research Center. 1994. 181p. (In Korean). Order Number DE96703567. Source: OSTI; NTIS (US Sales Only).

This study is to apply a wireless LAN to KEPCO LAN system. Accordingly, various investigation and analysis about wireless LAN are undertaked. In this paper, advantage and disadvantage, and sorts of wireless LAN are illustrated and a application of wireless LAN system for KEPCO is suggested. (author). 59 refs., figs.

31295 (LA-SUB–95-112) **Now Enhancing Working Skills: The "NEWS" Program. Final report.** Kuiper, A. (Merex Corp. (United States)). Los Alamos National Lab., NM (United States); Merex Corp. (United States). 23 Jan 1995. 13p. Sponsored by USDOE, Washington, DC (United States). DOE Contract W-7405-ENG-36. Order Number DE95017807. Source: OSTI; NTIS; GPO Dep.

In October of 1992, Los Alamos National Laboratory and Merex Corporation began a pilot basic skills program to enhance workers' skills. The program, known as the NEWS (Now Enhancing Working Skills) Program, was implemented by the Training and Development Group of the Human Resources Division. A group of 106 employees known as Radiological Control Technicians (RCTs) from ESH-1 (Environmental, Safety, and Health) were targeted to take mandated DOE (Department of Energy) training. The main goal of the LANL/Merex partnership was to help RCTs prepare for mandated DOE Rad Con training and job performance by improving their information processing and math skills. A second goal of this project was to use the information from this small group to make some predictions about the Laboratory as a whole. This final report contains the description and an appendix for the "NEWS" program. The topics in this report include Merex class descriptions, test score results for the MAT, the WAT, the TABE, and Challenge test, a follow-up survey to Merex IPS and math training, student feedback statistics for skills programs, and lessons learned from the program.

31296 (LA-SUB–95-139) **Research on Mega-Math: Discrete mathematics and computer science for children. Final report.** Fellows, M.R. (Victoria Univ., BC (Canada)). Los Alamos National Lab., NM (United States); Victoria Univ., BC (Canada). 26 Jun 1995. 6p. Sponsored by USDOE, Washington, DC (United States). DOE Contract W-7405-ENG-36. Order Number DE95017808. Source: OSTI; NTIS; GPO Dep.

The objective of the subcontract was to provide further research on the approach to mathematics education embodied in the workbook "This is Mega-Mathematics!" essentially produced under the subcontract and its preceding informal (alas!) cooperative arrangements. The workbook is now widely and freely distributed on the Internet under the copyright of the Los Alamos National Labs. This research was to consist of: (1) the development and dissemination of materials, (2) experimentation with use of the materials in classroom visits and other events, (3) communication of the ideas embodied in the materials to various forums concerned with mathematics education reform, (4) the development of connections to the computer games industry, (5) the development of new workbook-type materials, (6) publications, (7) the development of connections to Science Museums, (8) the development of uses of the Internet to make MegaMath materials and ideas available through that medium, (9) the stimulation of and coordination with other projects in mathematics education reform. All of these objectives have been accomplished in what should be regarded as one of the most interesting and cost-effective projects ever undertaken in mathematics education, a testimony to the vision and creative imagination of the Los Alamos Labs.

31297 (NUREG–0540) **Title list of documents made publicly available. Volume 17, No. 7.** Nuclear Regulatory Commission, Washington, DC (United States). Div. of Freedom of Information and Publications Services. Sep 1995. 260p. Sponsored by Nuclear Regulatory Commission, Washington, DC (United States). Source: OSTI; NTIS; INIS; GPO.

The Title List of Documents Made Publicly Available is a monthly publication. It contains descriptions of the information received and generated by the US Nuclear Regulatory Commission (NRC). This information includes (1) docketed material associated with civilian nuclear power plants and other uses of radioactive materials and (2) nondocketed material received and generated by NRC pertinent to its role as a regulatory agency. As used here, docketed does not refer to Court dockets; it refers to the system by which NRC maintains its regulatory records. This series of documents is indexed by a Personal Author Index, a Corporate Source Index, and a Report Number Index.

9901 Management

Refer also to citation(s) 28944, 29096, 29875, 30288, 30362, 31406

31298 (BNL–62187) **Review of laboratory programs for women Points-of-Contact Committee.** Duke, D. (National Renewable Energy Lab., Golden, CO (United States)); Magrini, K. (comps.); McLane, V. (comp.); Wieda, K. (comp.). Brookhaven National Lab., Upton, NY (United States). Jun 1995. 25p. Sponsored by USDOE, Washington, DC (United States). DOE Contract AC02-76CH00016. Order Number DE96000427. Source: OSTI; NTIS; GPO Dep.

The mission of the DOE Review of Laboratory Programs for Women is to: provide DOE and its Laboratories with effective strategies, targeting women, for establishing aggressive outreach programs which improve the access of women to careers in science, engineering, and mathematics. Ensure that the Department and its Laboratories are exemplary places of employment by providing programs which enhance opportunity, remove barriers, and assist women in achieving full professional development. A survey of the DOE facilities was undertaken by the Points-of-Contact for the DOE Review of Laboratory Programs for Women in order to gather data to be used as a baseline against which to measure future progress. We plan to look at current programs already in place and evaluate them with a view to deciding which programs are most effective, and selecting model programs suitable for implementation at other facilities. The survey focused on four areas: statistical data, laboratory policy, formal and informal programs which affect the quality of life in the work environment, and career development and advancement, and educational programs. Although this report focuses on women, the problems discussed affect all DOE facility employees.

31299 (DOE/ER/75955–T2) **Final technical report: Energy Works Lab, December 15, 1994–August 14, 1995.** Fort Worth Museum of Science and History, TX (United States). Interpretive Div. [1995]. 64p. Sponsored by USDOE, Washington, DC (United States). DOE Contract FG03-94ER75955. Order Number DE96000445. Source: OSTI; NTIS; GPO Dep.

The Energy Works Lab project was a two tier project consisting of the GIRLS SUMMER LAB and ENERGY WORKS. This final report is a summary of the completed project.

31300 (DOE-HDBK–7502-95-Vol.1) **Implementing US Department of Energy lessons learned programs. Volume 1.** USDOE, Washington, DC (United States). Aug 1995. 61p. Sponsored by USDOE, Washington, DC (United States). Order Number DE95017322. Source: OSTI; NTIS; GPO Dep.

Purpose of this handbook is provide DOE and DOE contractor organizations with information that can be used to modify existing lessons learned programs or to develop new programs.

31301 (DOE-HDBK–7502-95-Vol.2) **Implementing US Department of Energy lessons learned programs. Volume 2.** USDOE, Washington, DC (United States). Aug 1995. 100p. Sponsored by USDOE, Washington, DC (United States). Order Number DE95017323. Source: OSTI; NTIS; GPO Dep.

The DOE Lessons Learned Handbook is a two-volume publication developed to supplement the DOE Lessons Learned Standard (DOE-STD-7501-95) with information that will organizations in developing or improving their lessons learned programs. Volume 1 includes greater detail than the Standard in areas such as identification and documentation of lessons learned; it also contains sections on specific processes such as training and performance measurement. Volume 2 (this document) contains examples of program documents developed by existing lessons learned programs as well as communications material, functional categories, transmittal documents, sources of professional and industry lessons learned, and frequently asked questions about the Lessons Learned List Service.

31302 (INDC(NDS)–336) **Report of the IAEA Nuclear Data Section to the International Nuclear Data Committee for the period 1993/1994.** International Atomic Energy Agency, Vienna (Austria). International Nuclear Data Committee. Jul 1995. 55p. Order Number DE96602143. Source: OSTI; NTIS (US Sales Only); INIS.

This progress report describes the activities of the IAEA Nuclear Data Section in the years 1993 and 1994, including staff and budget, the operation of the Nuclear Data Center, the computer operations, the coordination activities of the Nuclear Data Center Networks, the nuclear data improvements projects, Technical Cooperation and technology transfer, atomic and molecular data activities, and the meetings held in the reporting period. (author). 7 tabs.

31303 (INIS-JP–032) **Proceedings of Japan-Russia joint workshop on radiation safety.** Kosako, Toshiso; Sugiura, Nobuyuki (eds.). Tokyo Univ. (Japan). Research Center for Nuclear Science and Technology. 1994. 242p. (CONF-9402156–: Japan-Russia joint workshop on radiation safety, Tokyo (Japan), 28 Feb - 3 mar 1994). Order Number DE96701431. Source: OSTI; NTIS; INIS.

This issue is the collection of the papers presented at the title meeting. The 13 of the presented papers are indexed individually. (J.P.N.).

31304 (INIS-JP–041) **KURRI progress report 1993. April 1993 - March 1994.** Kyoto Univ., Kumatori, Osaka (Japan). Research Reactor Inst. Oct 1994. 489p. Order Number DE95776795. Source: OSTI; NTIS (US Sales Only); INIS; Available from the Research Reactor Institute, Kyoto Univ., Kumatori-cho, Sennan-gun, Osaka-fu 590-04 (Japan).

In this third issue of the KURRI Progress Report, the summaries of Project Researches which started in fiscal year 1993 are included. These research areas fit in the five research areas which are pursued with priority in the future activities utilizing the KUR. The reactor KUR added 1600 h of operation during the past fiscal year, and the operation hours reached 227.4 Gh. 160 research works were added, and the total number became 4817. 1860 visiting researchers were accepted during the year, and the total number became 49,809. In the field of boron neutron capture therapeutics, 14 more patients were treated, which brought the total to 44. Now, there are 5 medical teams performing this therapy. The Atomic Energy Commission compiled the new 'Long term program for research, development and utilization of nuclear energy' in June, 1994. The research activities on slow neutron physics and neutron scattering, nuclear physics and nuclear chemistry, reactor physics and reactor engineering, material science and radiation effects, geochemistry and environmental science, life science and medical science, neutron capture therapy, neutron radiography and radiation application and radioactive waste management and health physics are reported. (K.I.).

31305 (INIS-mf–14565) **IAEA technical co-operation activities in the 1990s.** International Atomic Energy Agency, Vienna (Austria). Jan 1995. 35p. Order Number DE96602799. Source: OSTI; NTIS (US Sales Only); INIS.

The desire to extend the many benefits of the peaceful uses of nuclear technology to all countries led as long ago as 1957 to the establishment of the IAEA and to immediate introduction of a technical co-operation programme. In the more than thirty years that have passed since that time, the potential applications of nuclear techniques have greatly expanded. Over the period, many of the applications have moved from research laboratories into hospitals, farms and industrial enterprises. The direct resources made available to the IAEA by its Member States to support technology transfer processes have grown rapidly since the late 1950s. The current trends in the technical co-operation activities of the IAEA and some examples of projects supported by the IAEA are briefly presented in this document.

31306 (INIS-mf–14569) **Nuclear information: the IAEA and global nuclear communication.** Wedekind, L. (International Atomic Energy Agency, Vienna (Austria). Div. of Public Information). International Atomic Energy Agency, Vienna (Austria). Div. of Public Information; Comision de Energia Atomica, La Habana (Cuba). 1995. 9p. (CONF-9505292–: Regional seminar on public information of nuclear energy, Habana (Cuba), 17-19 May 1995). Order Number DE96602800. Source: OSTI; NTIS (US Sales Only); INIS.

The IAEA's activities regarding nuclear communication and information disclosure are treated in this paper.

31307 (INIS-mf–14570) **Public information activities in Cuba: The role of the Nuclear Energy Information Center.** Petinaud M, J. (Centro de Informacion de la Energia Nuclear, La Habana (Cuba)); Aguilar M, O. International Atomic Energy Agency, Vienna (Austria). Div. of Public Information; Comision de Energia Atomica, La Habana (Cuba). 1995. 14p. (In Spanish). (CONF-9505292–: Regional seminar on public information of nuclear energy, Habana (Cuba), 17-19 May 1995). Order Number DE96602801. Source: OSTI; NTIS (US Sales Only); INIS.

Cuba's efforts and especially those of the CIEN to ensure the scientific and technical information to specialist, as well as the disclosure of nuclear issues island wide, are treated in this paper.

31308 (LA-SUB–95-91) **M2 priority screening system for near-term activities: Project documentation. Final report December 11, 1992–May 31, 1994.** Los Alamos National Lab., NM (United States); Applied Decision Analysis, Inc., Menlo Park, CA (United States). 12 Aug 1993. 300p. Sponsored by USDOE, Washington, DC (United States). DOE Contract W-7405-ENG-36. Order Number DE95014559. Source: OSTI; NTIS; GPO Dep.

From May through August, 1993, the M-2 Group within M Division at LANL conducted with the support of the LANL Integration and Coordination Office (ICO) and Applied Decision Analysis, Inc. (ADA), whose purpose was to develop a system for setting priorities among activities. This phase of the project concentrated on prioritizing near-tenn activities (i.e., activities that must be conducted in the next six months) necessary for setting up this new group. Potential future project phases will concentrate on developing a tool for setting priorities and developing annual budgets for the group's operations. The priority screening system designed to address the near-term problem was developed, applied in a series of meeting with the group managers, and used as an aid in the assignment of tasks to group members. The model was intended and used as a practical tool for documenting and explaining decisions about near-term priorities, and not as a substitute for M-2 management judgment and decision-making processes.

31309 (SAND–95-2256C) **Applying the Laboratory Integration and Prioritization System (LIPS) to decision-making at Sandia National Laboratories.** Barber, D.S. (Sandia National Labs., Albuquerque, NM (United States). Services Management System Office); Mead, J.W. Sandia National Labs., Albuquerque, NM (United States). [1995]. 13p. Sponsored by USDOE, Washington, DC (United States). DOE Contract AC04-94AL85000. (CONF-9508169–1: Energy Facilities Contractors Operating Group, Prioritization Working Group & Prioritization Methodology Users Group prioritization methodology workshop, Idaho Falls, ID (United States), 22-23 Aug 1995). Order Number DE96000755. Source: OSTI; NTIS; GPO Dep.

The Laboratories Services Division of Sandia National Laboratories includes a wide variety of operations such as environmental, safety and health, safeguards and security, facilities, logistics, and sites planning and integration. In the face of declining budgets and increasing requirements, the Management Team needed some tools to assist in negotiating with customers and regulators and in consistently and cost-effectively managing all work performed and/or managed by the Division. The Integrated Services Management System (ISMS) was developed as a series of processes to provide these tools. The Laboratory Integration and Prioritization System (LIPS) was selected as the prioritization methodology for ISMS. The pilot application phase was begun in February 1994 and addressed planning of work and resources for FY95. Extensive training was provided for the Activity Data Sheet (ADS) preparers and the teams which would score each of the activities. After preparation of the ADSs, they were scored by the scoring teams. A division-wide review board reviewed all of the ADSs to ensure consistency of scoring across all of the functional areas. The lessons that were learned from the pilot application were evaluated and improvements incorporated for the FY96 planning and application. The improvements included upgrading the training, providing expert facilitation for scoring boards, modification of the scoring instructions to better represent local situations, and establishing an Validation Board with more authority and accountability to provide quality assurance. The participants in the LIPS process have agreed that no major bases were uncovered, imperfect prioritizations are better than no data, all work packages can be scored and ranked, including core activities, results were objective and quantifiable, and decisions could be made using technically defensible bases.

31310 (UCRL-ID–119329) **The role of risk-based prioritization in total quality management.** Bennett, C.T. Lawrence Livermore National Lab., CA (United States). Oct 1994. 26p. Sponsored by USDOE, Washington, DC (United States). DOE Contract W-7405-ENG-48. Order Number DE96001073. Source: OSTI; NTIS; GPO Dep.

The climate in which government managers must make decisions grows more complex and uncertain. All stakeholders - the public, industry, and Congress - are demanding greater consciousness, responsibility, and accountability of programs and their budgets. Yet, managerial decisions have become multifaceted, involve greater risk, and operate over much longer time periods. Over the last four or five decades, as policy analysis and decisions became more complex, scientists from psychology, operations research, systems science, and economics have developed a more or less coherent process called decision analysis to aid program management. The process of decision analysis - a systems theoretic approach - provides the backdrop for this paper. The Laboratory Integrated Prioritization System (LIPS) has been developed as a systems analytic and risk-based prioritization tool to aid the management of the Tri-Labs' (Lawrence Livermore, Los Alamos,

and Sandia) operating resources. Preliminary analyses of the effects of LIPS has confirmed the practical benefits of decision and systems sciences - the systematic, quantitative reduction in uncertainty. To date, the use of LIPS - and, hence, its value - has been restricted to resource allocation within the Tri-Labs' operations budgets. This report extends the role of risk-based prioritization to the support of DOE Total Quality Management (TQM) programs. Furthermore, this paper will argue for the requirement to institutionalize an evolutionary, decision theoretic approach to the policy analysis of the Department of Energy's Program Budget.

31311 (WR-B–95-08) **Audit of subsidized ancillary services at the Nevada Test site.** USDOE Office of Inspector General, Albuquerque, NM (United States). Western Regional Audit Office. 8 Sep 1995. 16p. Sponsored by USDOE, Washington, DC (United States). Source: OSTI (Free of Charge).

The Department and its contractors have participated in at least six reviews since 1991 encompassing aspects of subsidies at the test site. Several of these reviews resulted in reports recommending reductions to the housing, food, and bus services. A strategic planning report completed in November 1994, for example, recommended closing certain food service facilities, increasing housing rates to fair market value, and studying a bus depot system. Other reports echoed the same themes. The Department should be credited for recognizing that actions should be taken to reduce subsidy costs. Moreover, the Acting Manager, Nevada Operations office, has been proactive in reducing the busing subsidy by decreasing the number of buses and bus routes. The Acting Manager has also been fully supportive of the effort to further reduce subsidies. We appreciate these efforts.

9902 Mathematics and Computers

Refer also to citation(s) 28684, 28702, 28736, 28828, 28839, 28893, 28895, 28897, 28898, 28899, 28905, 28938, 28960, 28986, 29000, 29004, 29029, 29030, 29032, 29033, 29095, 29110, 29273, 29407, 29408, 29409, 29410, 29411, 29419, 29420, 29421, 29450, 29531, 29576, 29578, 29581, 29725, 29726, 29727, 29728, 29729, 29730, 29731, 29734, 29735, 29736, 29737, 29738, 29742, 29745, 29746, 29747, 29748, 29772, 29773, 29775, 29803, 29818, 29897, 29905, 29941, 29948, 29951, 29975, 29987, 30045, 30051, 30076, 30078, 30086, 30236, 30250, 30278, 30281, 30297, 30312, 30313, 30318, 30345, 30346, 30347, 30359, 30360, 30382, 30414, 30419, 30443, 30454, 30508, 30516, 30551, 30576, 30578, 30579, 30583, 30585, 30588, 30594, 30602, 30657, 30662, 30663, 30672, 30673, 30674, 30678, 30680, 30684, 30686, 30690, 30697, 30724, 30725, 30726, 30727, 30728, 30729, 30730, 30731, 30732, 30733, 30734, 30735, 30736, 30760, 30765, 30794, 30806, 30810, 30844, 30849, 30854, 30864, 30866, 30887, 30894, 30906, 30909, 31100, 31128, 31206, 31277, 31400, 31411

31312 (ANSTO/E–722) **Derivation of a macroscale formulation for a class of nonlinear partial differential equations.** Pantelis, G. Australian Nuclear Science and Technology Organisation, Lucas Heights, NSW (Australia). May 1995. 14p. Order Number DE96602796. Source: OSTI; NTIS; INIS.

A macroscale formulation is constructed from a system of partial differential equations which govern the microscale dependent variables. The construction is based upon the requirement that the solutions of the macroscale partial differential equations satisfy, in some approximate sense, the system of partial differential equations associated with the microscale. These results are restricted to the class of nonlinear partial differential equations which can be expressed as polynomials of the dependent variables and their partial derivatives up to second order. A linear approximation of transformations of second order contact manifolds is employed. 6 refs.

31313 (CONF-9406184–Final) **Fifth SIAM conference on applied linear algebra. Final report.** Lewis, J.G.; Gilbert, J.R.; Parlett, B.N. Society for Industrial and Applied Mathematics, Philadelphia, PA (United States). 16 Nov 1994. 29p. Sponsored by USDOE, Washington, DC (United States). DOE Contract FG02-94ER25197. From 5. SIAM conference on applied linear algebra; Snowbird, UT (United States); 15-18 Jun 1994. Order Number DE95016992. Source: OSTI; NTIS; GPO Dep.

The SIAM Conferences on Applied Linear Algebra are the centerpiece of activities for the SIAG on Linear Algebra. They are held every three years and bring together a diverse group of applied linear algebraists, representing industry, government and academics in both matrix theory and matrix computations. This sequence of conferences has two related goals: (1) to be useful and interesting to linear algebraists of every area of specialization, and, (2) to develop and expose connections among problems in different areas. Many aspects of the 1994 conference were carefully chosen to enhance interchange between the various groups and yet still provide a solid focus on specialities. The organizing committee adopted a new meeting structure to resolve the conflict between these two goals at earlier meetings in the series. We have prepared this report for others who may wish to consider our structure as an alternative to more traditional arrangements.

31314 (CONF-941273–Suppl.) **Special parallel processing workshop.** Lawrence Livermore National Lab., CA (United States). Dec 1994. 80p. Sponsored by USDOE, Washington, DC (United States). DOE Contract W-7405-ENG-36. From Special parallel process workshop; Livermore, CA (United States); 6-7 Dec 1994. Order Number DE96000061. Source: OSTI; NTIS; GPO Dep.

This report contains viewgraphs from the Special Parallel Processing Workshop. These viewgraphs deal with topics such as parallel processing performance, message passing, queue structure, and other basic concept detailing with parallel processing.

31315 (DOE/ER/25188–T1) **Report of the Federal Internetworking Requirements Panel.** National Inst. of Standards and Technology, Gaithersburg, MD (United States). 31 May 1994. 45p. Sponsored by USDOE, Washington, DC (United States). DOE Contract AI02-93ER25188. Order Number DE95017761. Source: OSTI; NTIS; GPO Dep.

The Federal Internetworking Requirements Panel (FIRP) was established by the National Institute of Standards and Technology (NIST) to reassess Federal requirements for open systems networks and to recommend policy on the Government's use of networking standards. The Panel was chartered to recommend actions which the Federal Government can take to address the short and long-term issues of interworking and convergence of networking protocols–particularly the Internet Protocol Suite (IPS) and Open Systems Interconnection (OSI) protocol suite and, when appropriate, proprietary protocols. The Panel was created at the request of the Office of Management and Budget in collaboration with the Federal Networking Council and the Federal Information Resources Management Policy Council. The Panel's membership and charter are contained in an appendix to this report.

31316 (DOE/OR/21400–T482) **Development of a modular integrated control architecture for flexible manipulators. Final report.** Burks, B.L. (Oak Ridge National Lab., TN (United States)); Battiston, G. Oak Ridge National Lab., TN (United States). 8 Dec 1994. 8p. Sponsored by USDOE, Washington, DC (United States). DOE Contract AC05-84OR21400. Order Number DE96000762. Source: OSTI; NTIS; INIS; GPO Dep.

In April 1994, ORNL and SPAR completed the joint development of a manipulator controls architecture for flexible structure controls under a CRADA between the two organizations. The CRADA project entailed design and development of a new architecture based upon the Modular Integrated Control Architecture (MICA) previously developed by ORNL. The new architecture, dubbed MICA-II, uses an object-oriented coding philosophy to provide a highly modular and expandable architecture for robotic manipulator control. This architecture can be readily ported to control of many different manipulator systems. The controller also provides a user friendly graphical operator interface and display of many forms of data including system diagnostics. The capabilities of MICA-II were demonstrated during oscillation damping experiments using the Flexible Beam Experimental Test Bed at Hanford.

31317 (EGG–11265-1130) **An information management and communications system for emergency operations.** Gladden, C.A.; Doyle, J.F. EG and G Energy Measurements, Inc., Las Vegas, NV (United States). [1995]. 3p. Sponsored by USDOE, Washington, DC (United States). DOE Contract AC08-93NV11265.

(CONF-950430–12: 5. ANS topical meeting on emergency preparedness and response, Savannah, GA (United States), 18-21 Apr 1995). Order Number DE96000154. Source: OSTI; NTIS; GPO Dep.

In the mid 1980s the US Department of Energy (DOE) recognized the need to dramatically expand its Emergency Operations Centers to deal with the large variety of emergencies for which DOE has an obligation to manage, or provide technical support. This paper describes information management, display, and communications systems that have been implemented at the DOE Headquarters Forestall Operations Center (OC), DOE Operations Offices, and critical laboratory locations. Major elements of the system at the DOE Headquarters facility include computer control, information storage and retrieval, processing, Local Area Networks (LANs), videoconferencing, video display, and audio systems. These Headquarters systems are linked by Wide Area Networks (WANs) to similar systems at the Operations Office and critical Laboratory locations.

31318 (EGG–11265-5031) **Virtual instruments – A Los Alamos experiment.** Khalsa, N.S. EG and G Energy Measurements, Inc., Los Alamos, NM (United States). Los Alamos Operations. [1995]. 15p. Sponsored by USDOE, Washington, DC (United States). DOE Contract AC08-93NV11265. (CONF-9505286–1: Digital signal processing conference and exposition, San Jose, CA (United States), 15-19 May 1995). Order Number DE96000190. Source: OSTI; NTIS; GPO Dep.

Changing priorities, shrinking budgets, reduced personnel, and collapsed time schedules in post-Cold War Los Alamos have forced project managers to face software "time-to-market" issues similar to their commercial counterparts. Programs that are funded over a period of several years are now the exception rather than the norm. Projects are much more diverse and have more clearly defined goals and termination points compared with the previous objective of incremental improvements through a series of developmental efforts. Software development and support for such projects has to be less costly than before, since the software is a "throw-away" when the project is over. The authors came up with a wish list for a software development system that would meet their needs. The list includes: (1) higher productivity, faster turnaround than the present approach of starting from scratch in C or FORTRAN; (2) flexibility–able to make moderate changes in program flow without significant setbacks in the development schedule; (3) high-level focus–spending more time on the algorithms and less time on GUI or driver issues; (4) greater code reusability, and good mechanisms for documenting code flow and code modifications; (5) multiplatform implementations–IBM-PC, Sun, Mac, not so much for code porting but for user training issues; (6) reasonable code execution speeds–able to keep up with data acquisition rates required for the project; (7) ability to link-in external code when necessary; (8) sufficient debugging tools; (9) satisfactory product support and response times to questions (hours, not days); and (10) vital life signs from the vendor's R and D department–upgrades, bug fixes, enhancements, response to customer feedback.

31319 (ESTSC–000138FUJ5000) **DYNA3DREV5. Explicit 3-d Hydrodynamic FEM Program.** Wolery, T. (Lawrence Livermore National Lab., CA (United States)). Fujitsu Systems Business of America, Inc., Santa Clara, CA (United States). 1 May 1991. Sponsored by USDOE, Washington, DC (United States). Source: ESTSC.

Description: FUJITSUVPP500; UXP/M V10L10; FORTRAN; 1 QIC Cartridge. Instead of running the program interactively, the execution can be submitted to the background now.

DYNA3DREV5 is an explicit, three-dimensional, finite element program for analyzing the large deformation dynamic response of inelastic solids and structures. DYNA3DREV5 contains 30 material models and 10 equations of state (EOS) to cover a wide range of material behavior. The material models implemented are: elastic, orthotropic elastic, kinematic/isotropic plasticity, thermoelastoplastic, soil and crushable foam, linear viscoelastic, Blatz-Ko rubber, high explosive burn, hydrodynamic without deviatoric stresses, elastoplastic hydrodynamic, temperature-dependent elastoplastic, isotropic elastoplastic, isotropic elastoplastic with failure, soil and crushable foam with failure, Johnson/Cook plasticity model, pseudo TENSOR geological model, elastoplastic with fracture, power law isotropic plasticity, strain rate dependent plasticity, rigid, thermal orthotropic, composite damage model, thermal orthotropic with 12 curves, piecewise linear isotropic plasticity, inviscid two invariant geologic cap, orthotropic crushable model, Moonsy-Rivlin rubber, resultant plasticity. The hydrodynamic material models determine only the deviatoric stresses. Pressure is determined by one of 10 equations of state including linear polynomial, JWL high explosive, Sack Tuesday high explosive, Gruneisen, ratio of polynomials, linear polynomial with energy deposition, ignition and growth of reaction in HE, tabulated compaction, tabulated, and TENSOR pore collapse. DYNA3DREV5 generates three binary output databases. One contains information for complete states at infrequent intervals; 50 to 100 states is typical. The second contains information for a subset of nodes and elements at frequent intervals; 1,000 to 10,000 states is typical. The last contains interface data for contact surfaces.

31320 (ESTSC–000154FUJ5000) **KIVA2. 2D & 3D Reactive Flows With Fuel Sprays.** Amsden, A.A. (Sandia National Labs., Albuquerque, NM (United States)). Fujitsu Systems Business of America, Inc., Santa Clara, CA (United States). 1 May 1989. Sponsored by USDOE, Washington, DC (United States). Source: ESTSC.

Description: FUJITSUVPP500; MSP; FORTRAN; 1 Mag Tape. Several SLATEC3.1 and LINPACK routines are called. These routines are provided. KIVA2 also calls some CTSS system routines and LANL-specific graphics routines. These routines are not provided but are described at the end of the FORTRAN source.

KIVA2 solves the equations of transient, two and three-dimensional, chemically reactive fluid flow with sprays. The KIVA2 equations and numerical solution procedure are very general and can be applied to laminar or turbulent flows, subsonic or supersonic flows, and single-phase or dispersed two-phase flows. Arbitrary numbers of chemical species and reactions are allowed. A stochastic particle method is used to calculate evaporating liquid sprays, including the effects of droplet collisions and aerodynamic breakups. Although the initial and boundary conditions and mesh generation were written for internal combustion energy calculations, the logic for these specifications can be easily modified for a variety of other applications.

31321 (ESTSC–000154FUJ5001) **KIVA3. 2D & 3D Reactive Flows With Fuel Sprays.** Amsden, A.A. (Los Alamos National Lab., NM (United States)). Fujitsu Systems Business of America, Inc., Santa Clara, CA (United States). 1 May 1989. Sponsored by USDOE, Washington, DC (United States). Source: ESTSC.

Description: FUJITSUVPP500; MSP; FORTRAN; 1 QIC Cartridge. Several SLATEC3.1 and LINPACK routines are called. These routines are provided. KIVA3 also calls some CTSS system routines and LANL-specific graphics routines. These routines are not provided but are described at the end of the FORTRAN source.

KIVA3 solves the equations of transient, two and three-dimensional, chemically reactive fluid flow with sprays. The KIVA3 equations and numerical solution procedure are very general and can be applied to laminar or turbulent flows, subsonic or supersonic flows, and single-phase or dispersed two-phase flows. Arbitrary numbers of chemical species and reactions are allowed. A stochastic particle method is used to calculate evaporating liquid sprays, including the effects of droplet collisions and aerodynamic breakups. Although the initial and boundary conditions and mesh generation were written for internal combustion energy calculations, the logic for these specifications can be easily modified for a variety of other applications.

31322 (ESTSC–000260SPARC00) **VIEW. Signal and Image Processing Operations.** Brase, J. (Lawrence Livermore National Lab., CA (United States)); Wieting, M.; Miller, V. Lawrence Livermore National Lab., CA (United States). 1 Feb 1995. Sponsored by Lawrence Livermore National Lab., CA (United States). Source: ESTSC.

Description: SUN SPARC; Computers running UNIX with X WiC, FORTRAN; 1 Tape.

VIEW is a software system for processing arbitrary multidimensional signals. It provides facilities for numerical operations, signal displays, and signal databasing. The major emphasis of the system

is on the processing of time-sequences and multidimensional images. The system is designed to be both portable and extensible. It runs currently on UNIX systems, primarily SUN workstations.

31323 (ESTSC–000324IB38602) **EQ3/6 V7.2B. Geochemical Modeling Of Aqueous Systems.** Wolery, T.A. (Lawrence Livermore National Lab., CA (United States)). Lawrence Livermore National Lab., CA (United States). 30 Jul 1993. Sponsored by USDOE, Washington, DC (United States). DOE Contract W-7405-ENG-48. Source: ESTSC; Lawrence Livermore National Lab.

Description: IBM PC 386; DOS 6.2 or later with MicroSoft Lahey extended Fortran (F77L-EM/32, v. 5.11) with DOS system calls; 5 3.5 Diskettes. EQ3NR input files end in .3i, EQ6 input files end in .6i. This is a recommended convention, and it is required in order to run these codes using the PC interface software. The data file names have the form exemplified by data0.com. Here com is one of the five data file descriptors. This general form is required to run the RUNEQPT script. The main code FORTRAN source files end in .fsc. The PC interface software source codes end in .for. The EPCLIB library supports the PC interface codes. This library is included in the distribution package.

EQ3/6 is a software package for geochemical modeling of aqueous systems. This description pertains to version 7.2b. It addresses aqueous speciation, thermodynamic equilibrium, disequilibrium, and chemical kinetics. The major components of the package are EQ3NR, a speciation-solubility code, and EQ6 a reaction path code. EQ3NR is useful for analyzing groundwater chemistry data, calculating solubility limits, and determining whether certain reactions are in states of equilibrium or disequilibrium. It also initializes EQ6 calculations. EQ6 models the consequences of reacting an aqueous solution with a specified set of reactants (e.g., minerals or waste forms). It can also model fluid mixing and the effects of changes in temperature. Each of five supporting data files contain both standard state and activity coefficient-related data. Three support the use of the Davies or B-dot equations for the activity coefficients; the other two support the use of Pitzer's equations. The temperature range of the thermodynamic data on the data files varies from 25 degrees C only to 0-300 degrees C.

31324 (ESTSC–000324SUN0004) **EQ3/6 V7.2B. Geochemical Modeling of Aqueous Systems.** Wolery, T.J. (Lawrence Livermore National Lab., CA (United States)). Lawrence Livermore National Lab., CA (United States). 14 Sep 1992. Sponsored by USDOE, Washington, DC (United States). DOE Contract W-7405-ENG-48. Source: ESTSC; Lawrence Livermore National Lab.

Description: SUN; UNIX; ANSI FORTRAN 77; UNIX interface software, C-shell UNIX; 3 3.5 Diskettes. EQ3NR input files end in .3i, EQ6 input files end in .6i. This is a recommended convention, and it is required in order to run these codes using the UNIX interface software. The data file names have the form exemplified by data0.comR22. Here com is one of the five data file descriptors and R22 is a stage number (a configuration control identifier). The main code FORTRAN source files end in .fsc. The EQLIB library package supports the EQPT, EQ3NR, and EQ6 codes. This library is included with the package.

EQ3/6 is a software package for geochemical modeling of aqueous systems. This description pertains to version 7.2B. It addresses aqueous speciation, thermodynamic equilibrium, disequilibrium, and chemical kinetics. The major components of the package are EQ3NR a speciation-solubility code and EQ6, a reaction path code. EQ3NR is useful for analyzing groundwater chemistry data, calculating solubility limits, and determining whether certain reactions are in states of equilibrium or disequilibrium. It also initializes EQ6 calculations. EQ6 models the consequences of reacting an aqueous solution with a specified set of reactants (e.g. minerals or waste forms). It can also model fluid mixing and the effects of changes in temperature. Each of five supporting data files contains both standard state and activity coefficient-related data. Three support the use of the Davies or B-dot equations for the activity coefficients; the other two support the use of Pitzer's equations. The temperature range of the thermodynamic data on the data files varies from only 25 degrees C to 0-300 degrees C.

31325 (ESTSC–000816AL00000) **MAP. Builds/Maintains 2D Grid Maps of Sensor Data in Real-Time.** Drotning, W.D. (Sandia National Labs., Albuquerque, NM (United States)). Sandia National Labs., Albuquerque, NM (United States). 1 Aug 1991. Sponsored by USDOE, Washington, DC (United States). Source: ESTSC.

Description: APPLE MACINTOSH; VxWorks, version 4; C; 1 3.5 Diskette. Requires include files map.h, sonx.h, xvme.h (included). Source is in map.c file.

The function of MAP is to build and maintain two dimensional (2D) grid maps of information. For example, MAP has been used to combine robot position data and ultrasonic range measurement data to generate surface elevation maps in real-time, or with metal detector data for metal signal intensity mapping. Although originally written to handle processed sensor data, the functional capability of MAP allows it to be used for any type of 2D information. Subregions of the primary 2D map are maintained which have independent grid resolution. System data and information are available through function calls, global data structures, and via client/server commands. The MAP software includes the following functional features: control, data processing, and server commands.

31326 (ESTSC–000817AL00000) **MESH. Builds/Maintains 2D Grid Maps of Sensor-Detected Obstacles in Real-Time.** Drotning, W.D. (Sandia National Labs., Albuquerque, NM (United States)). Sandia National Labs., Albuquerque, NM (United States). 1 Aug 1991. Sponsored by USDOE, Washington, DC (United States). Source: ESTSC.

Description: APPLE MACINTOSH; VxWorks, version 4; C; 1 3.5 Diskette. Requires include files mesh.h, sonx.h, xvme.h (included). Source is in mesh.c file.

The function of MESH is to build and maintain two dimensional (2D) grid maps of detected obstacles. Obstacle detection and mapping are performed by combining position and range-to-target information. For example, MESH has been used to combine robot position data and ultrasonic range measurement data form sensors to generate a 2D obstacle map in real-time for robotic obstacle detection and collision avoidance. Although orginally written to handle processed sensor data, the functional capability of MESH allows it to be used for any type of 2D information. An external client can access the 2D obstacle map for computer model generation of objects. In order to provide robust obstacle detection from noisy data, the software design contains features for statistical analysis to obtain noise immunity, dynamic thresholding for obstacle detection and strength measurement, nearest neighbor grid interactions, and sensor weighting capabilities. In addition, the algorithms which process information into the obstacle map include obstacle shadowing effects and the concept of a sensor range horizon. System data and information are available through function calls, global data structures, and via client/server commands. The MESH software includes the following functional features: control, data processing and server commands.

31327 (ESTSC–000829SUN0000) **CLERVER. Interactive Collaborative Environments.** Dean, C. (Sandia National Labs., Albuquerque, NM (United States)); Lin, H.; Pastorek, B.; Bauer, K.; Volkmer, G. Sandia National Labs., Albuquerque, NM (United States). 1 Jun 1993. Sponsored by USDOE, Washington, DC (United States). Source: ESTSC.

Description: SUN; UNIX, X-11 R5; The source code is written in C.; 1 Tape. CLERVER only shares applications running under X-windows or X-server.

Time has been an invaluable commodity. In today's workplace of increased workload and shorter deadlines, solutions must be found to share electronic information quickly if not immediately. Teams would often have to schedule face-to-face meetings to share ideas which often proved to be expensive in both dollars and time if the participants were required to travel long distances. Software engineers at Sandia National Laboratories in Albuquerque, New Mexico, have developed a solution for this problem. The solution is a software product called ICE. The heart of ICE is the CLERVER which allows teams to collaborate via their own workstation with one another and view changes in real time. CLERVER's capabilities allow; immediate feedback, quicker decisions, first-hand involvement, broader participation, and interactive on-line problem solving. This sharing allows users to utilize only one copy of an application and share with up to 20 additional users. Each user in the session appears to be running the application locally, but in fact, the application only resides on one machine. When the session is

over, any changes made and saved are recorded on the system where the valid application license resides.

31328 (ESTSC–000831SPARC00) **RIPE/RIPL. Robot Independent Programming Environment and Language.** Miller, D. (Sandia National Laboratories, Albuquerque, NM (United States)); Lennox, R.C.; Fahrenholtz, J.; Shinn, R.; Rhea, R.; Rogers, M. Sandia National Labs., Albuquerque, NM (United States). 1 Jan 1990. Sponsored by USDOE, Washington, DC (United States). DOE Contract AC04-76DP00789. Source: ESTSC.

Description: SUN SPARC; UNIX, Vx Works; 97% C++, 3% C; 1 QIC Cartridge. Requires the Monitor program for particular robot being used.

RIPE is an object-oriented approach to robot system architectures; it is a software environment which facilitates rapid design and implementation of complex robot systems for diverse applications. The robot work cell is modeled using software objects and supports model-based automated programming of robotic and machining devices, real-time sensor-based control, error handling, robust communications and graphical interfaces for robot system control. The objects include robots, sensors, end effectors, workpieces, NC machines and various other devices. A set of generic classes is defined to represent these objects, and the interfaces to them become RIPL.

31329 (ESTSC–000987IBMPC00) **DOTS7.4. Image Analysis for Sequencing by Hybridization of DNA Fragments.** Jarvis, J. (Argonne National Laboratory, IL (United States)); Drmanac, R. Argonne National Lab., IL (United States). 1 Mar 1993. Sponsored by USDOE, Washington, DC (United States). Source: ESTSC.

Description: IBM PC; DOS 5.0; Borland C++ 3.00; 1 3.5 Diskette. The 16-bit TIFF input (.GEL) files are created by Molecular Dynamics ImageQuant sotware on their PhosphorImager. This version of DOTS accesses the large (3- to 20-megabyte) .GEL files on either a DOS disk or on a UNIX disk, connected to DOS via PC-NFS, the Sun network package.

DOTS is an image analysis program which extracts thousands of dot values from TIFF image files produced by a Molecular Dynamics Phosphorimager in the sequence by hybridization (SBH) process of DNA sequencing. Physical dots are tiny spots of DNA deposited by a robot on a nylon membrane, which are then exposed to radioactive probes of known sequence. When a probe hybridizes to a dot with complementary sequence, a signal of higher intensity is generated. The output of the DOTS program is a measurement of volume, peak value, and locations of center of mass and peak for dot each clone. This information is accumulated for many probes to build up a signature profile for each dot. Dot clones which have novel signatures are identified to be sequenced by conventional methods or they may be sequenced by SBH methods, provided the oligo overlap density is high enough and branching point ambiguties can be resolved.

31330 (ESTSC–001001SPARC00) **FORMBUILDER. FORMBUILDER/FBGRAPHICS.** Goetsch, J.A. (Idaho National Engineering Laboratory, Idaho Falls, ID (United States)). EG and G Idaho, Inc., Idaho Falls, ID (United States). 1 Sep 1994. Sponsored by USDOE, Washington, DC (United States). DOE Contract AC07-94ID13223. Source: ESTSC.

Description: SUN SPARC; FormBuilder and FBGraphics libraC programming language; 1 3.5 Diskette. FormBuilder and FBGraphics are both written in the C programming language since they are an interface layer to other C libraries. Parallel Ada bindings are also provided. The Ada bindings are not necessarily between compilers since, by nature, they require use of vendor specific capabilities of the Ada compiler. They are currently written and tested under Rational Apex version 1.4.1. A port to some Ada compilers, such as the Verdix Ada compiler should be trivial while some others may be more involved.

FormBuilder is a software library developed at the INEL that provides the programmer with a high-level interface to a subset of the X Window system and the OSF/Motif widget set. The primary goal of the FormBuilder library is to assist the programmer in rapidly developing a OSF/Motif based Graphical User Interface (GUI). Through the use of the FormBuilder application programmers interface (API), the GUI programmer is afforded several distinct advantages over Motif programming. Among these advantages are a substantially reduced learning curve, more readable/maintainable/modifiable code, smaller, more efficient binaries, and reduced compile/link/debug time during development. Working in concert with the FormBuilder library is the FBGraphics library, a 2-dimensional graphics library that allows the programmer to perform graphical operations within certain FormBuilder windows. The FBGraphics library is based on the Xlib drawing routines and much like FormBuilder, its purpose is to provide the programmer with a simpler, more productive mechanism for producing the desired graphical output on the screen.

31331 (ESTSC–001037MLTPL00) **VHDL CONTROL ROUTER. VHDL Control Routing Simulator.** Venard, J. (Fermi Accelerator Lab., Batavia, IL (United States)). Fermi National Accelerator Lab., Batavia, IL (United States). 1 Mar 1994. Sponsored by USDOE, Washington, DC (United States). Source: ESTSC.

Description: MLT-PLTFM; Any sysem for which standard VND-VHDL; 1 Mag Tape.

The control router simulates a backplane consisting of up to 16 slot. Slot 0, reserved for a control module (cr-ctrl), generates the system clocks and provides the serial interface to the Gating Logic. The remaining 15 slots (1-15) contain routing modules (cr mod), each having up to 64 serial inputs and outputs with FIFOs. Messages to be transmitted to the Control Router are taken from text files. There are currently 17 such source files. In the model, the serial output of each source is connected to multiple receivers, so that there are 8 identical messages transmitted to the router for each message file entry.

31332 (ESTSC–001051SUN0000) **CAPS-2D. Casting Process Simulator 2D Mold Fill and Solidification.** Domanus, H.M. (Argonne National Laboratory, Argonne, Il, (United States)); Schmitt, R.C. Argonne National Lab., IL (United States). 1 Mar 1995. Sponsored by USDOE, Washington, DC (United States). Source: ESTSC.

Description: SUN; SunOS 4.1.3 with Open Windows 3.FORTRAN 77 with some VMS extensions (99%) and C (1%) plus UNIX System 5 Bourne shell scripts.;1 Tape.

The CaPS software is a tool used to setup, simulate, and examine the results from two-dimensional filling and solidification of a sand casting.

31333 (ESTSC–001059IBMPC00) **HOTSPOT. Gaussian Dispersion Model for Radioactive Materials.** Homann, S.G. (Lawrence Livermore National Lab., CA (United States)). Lawrence Livermore National Lab., CA (United States). Hazards Control Dept. 1 Mar 1995. Sponsored by USDOE, Washington, DC (United States). Source: RADIATION SHIELDING INFORMATION CENTER.

Description: IBM PC; The only operating system requirBORLAND TURBO PASCAL 7.0; 1 3.5 Diskette.

The HOTSPOT Health Physics codes were created to provide Health Physics personnel with a fast, field-portable calculational tool for evaluating accidents involving radioactive materials. HOTSPOT codes are a first-order approximation of the radiation effects associated with the atmospheric release of radioactive materials. HOTSPOT programs are reasonably accurate for a timely initial assessment. More importantly, HOTSPOT codes produce a consistent output for the same input assumptions and minimize the probability of errors associated with reading a graph incorrectly or scaling a universal nomogram during an emergency. Four general programs, PLUME, EXPLOSION, FIRE, and RESUSPENSION, calculate a downwind assessment following the release of radioactive material resulting from a continuous or puff release, explosive release, fuel fire, or an area contamination event. Other programs deal with the release of plutonium, uranium, and tritium to expedite an initial assessment of accidents involving nuclear weapons. Additional programs estimate the dose commitment from inhalation of any one of the radionuclides listed in the database of radionuclides, calibrate a radiation survey instrument for ground survey measurements, and screening of plutonium uptake in the Lung.

31334 (ESTSC–001060MC68H00) **SOLARTRAK. Solar Array Tracking Control.** Manish, A.B. (Sandia National Laboratory, Albuquerque, NM (United States)); Dudley, J. Sandia National Labs.,

Albuquerque, NM (United States). 1 Jun 1995. Sponsored by USDOE, Washington, DC (United States). Source: ESTSC.

Description: MOTOROLAMC68HC1; Solar Trak Control Board; C; 1 3.5 Diskette. Various assemble-time options are available with the software for the Control Board. The software is formatted for the 2500AD Ver 4.05e assembler (not provided). The User-Board software is written in C format for the Intermetrics Whitesmith C compiler version 3.32.10 (not provided).

SolarTrak used in conjunction with various versions of 68HC11-based SolarTrack hardware boards provides control system for one or two axis solar tracking arrays. Sun position is computed from stored position data and time from an on-board clock/calendar chip. Position feedback can be by one or two offset motor turn counter square wave signals per axis, or by a position potentiometer. A limit of 256 counts resolution is imposed by the on-board analog to digital (A/D) convertor. Control is provided for one or two motors. Numerous options are provided to customize the controller for specific applications. Some options are imposed at compile time, some are setable during operation. Software and hardware board designs are provided for Control Board and separate User Interface Board that accesses and displays variables from Control Board. Controller can be used with range of sensor options ranging from a single turn count sensor per motor to systems using dual turn-count sensors, limit sensors, and a zero reference sensor. Dual axis trackers oriented azimuth elevation, east west, north south, or polar declination can be controlled. Misalignments from these orientations can also be accommodated. The software performs a coordinate transformation using six parameters to compute sun position in misaligned coordinates of the tracker. Parameters account for tilt of tracker in two directions, rotation about each axis, and gear ration errors in each axis. The software can even measure and compute these prameters during an initial setup period if current from a sun position sensor or output from photovoltaic array is available as an anlog voltage to the control board's A/D port. Wind or emergency stow to aj present position is available triggered by digital or analog signals. Night stow is also available. Tracking dead band is adjustable from narrow to wide. Numerous features of the hardware and software conserve energy for use with battery powered systems.

31335 (ETDE/CH-mf–95787322, pp. 99-102) **Suppression of higher harmonics in nonlinear periodically driven stochastic systems.** Talkner, P. (Paul Scherrer Inst. (PSI), Villigen (Switzerland)); Jung, P. Paul Scherrer Inst. (PSI), Villigen (Switzerland). 1995. In *Paul Scherrer Institut annual report 1994. Annex V: PSI general energy technology newsletter 1994.* 123p. Source: OSTI; NTIS.

We consider the generation of higher harmonics in periodically driven noisy nonlinear systems. Recent numerical studies of higher harmonics in such systems have shown so-called noise induced resonances that manifest themselves in a strong suppression of higher harmonics at certain values of the noise level. A theory of this peculiar phenomenon is presented, unmasking the universal character of these resonances and their widespread occurrence. (author) 2 figs., 9 refs.

31336 (INEL–94/00081) **Investigation of Newton-Krylov algorithms for low Mach number compressible flow.** McHugh, P.R.; Knoll, D.A.; Mousseau, V.A.; Hansen, G.A. Idaho National Engineering Lab., Idaho Falls, ID (United States). [1995]. 7p. Sponsored by USDOE, Washington, DC (United States). DOE Contract AC07-94ID13223. (CONF-950853–7: ASME/JSME annual summer meeting of the Fluids Engineering conference, Hilton Head, SC (United States), 13-17 Aug 1995). Order Number DE96001622. Source: OSTI; NTIS; GPO Dep.

Fully coupled Newton-Krylov algorithms are used to solve steady speed compressible flow past a backward facing step flow Mach and Reynolds numbers. Various preconditioned Krylov iterative methods are used to solve the linear systems that arise on each Newton step, specifically Lanczos-based and Arnoldi-based algorithms. Several preconditioning strategies are considered to improve the performance of these iterative techniques, including incomplete lower-upper factorization with various levels of fill-in [ILU(k)] and domain based additive and multiplicative Schwarz type preconditioning both with and without overlapping domains. The ILU(K) preconditioners were generally less reliable for lower values of the flow Mach number, and exhibited strong sensitivity to cell ordering. In addition, the parallel nature of the domain based preconditioners is exploited on both a shared memory computer and a distributed system of workstations. Important aspects of the numerical solutions are discussed.

31337 (KRC–92H-J02) **An Improvement of the Numerical Analysis Program and Experimental Study for the Foundation of Rotating machine.** Lee, J.R. (Korea Electric Power Corp. (KEPCO), Taejon (Korea, Republic of). Research Center); Lee, D.S.; Seo, Y.P.; Jeon, K.S.; Son, Y.S.; Cho, C.H.; Kim, K.H.; Kim, S.H.; Ku, K.O.; Chang, W.S.; Choi, M.S.; Hwang, K.H.; Cho, K.H.; Han, S.H.; Chang, S.P.; IKorea Electric Power Corp. (KEPCO), Taejon (Korea, Republic of). Research Center. 1993. 225p. (In Korean). Order Number DE96703596. Source: OSTI; NTIS (US Sales Only).

The turbine-generator foundation is one of major structure in power plants and is a very precise civil structure. The technology for design of foundation has been developed to reduce the transmitted loads due to the eccentricity of rotors into substructures such as column, mats, soil so on. As a result, the sets of spring are placed between the upper deck and the end of columns, which represents the low-tuned spring foundation. However, the transmission of loads from substructures to machine in case of earthquake or blasting loads has not been well described experimentally. Using the shaking table we have hence tested the one tenth reduced scale models of spring mounted turbine-generator foundation whose prototype is the T/G foundation of Ulsan fossile power plant. The scale of model has been determined by considering the sizes of prototype(41.5x14x12m) and that of shaking table(4x4m). In order to perform the project successfully, we have studied the followings; -Preparation of the background theory for computer program -Design and construction of model -Experimental tests by using shaking table -Comparison of theoretical with experimental results. (author). 22 refs., fig.

31338 (LA–13031-MS) **An analysis of containment, surveillance, and authentication for software.** Hunteman, W.J. Los Alamos National Lab., NM (United States). Sep 1995. 8p. Sponsored by USDOE, Washington, DC (United States). DOE Contract W-7405-ENG-36. Order Number DE96001358. Source: OSTI; NTIS; GPO Dep.

The "Protection, Containment, Surveillance, and Authentication (PCSA)" software was evaluated. The purpose of the evaluation was to determine the effectiveness of PCSA software in meeting the goals of a cost-effective, non-intrusive method for software authentication. Conclusions from the evaluation include (1) Commercially available software should be evaluated for the ability to provide the necessary control of access to and use of a PC. (2) The proposed software authentication methodology is not a cost-effective solution for the Agency and should be abandoned.

31339 (LA-SUB–95-60) **Summer 1994 Computational Science Workshop. Final report.** Los Alamos National Lab., NM (United States); New Mexico Univ., Albuquerque, NM (United States). Dept. of Electrical and Computer Engineering. [1994]. 47p. Sponsored by USDOE, Washington, DC (United States). DOE Contract W-7405-ENG-36. LANL-Subcontract-9-XU0-D1200-1. Order Number DE95016515. Source: OSTI; NTIS; GPO Dep.

This report documents the work performed by the University of New Mexico Principal Investigators and Research Assistants while hosting the highly successful Summer 1994 Computational Sciences Workshop in Albuquerque on August 6–11, 1994. Included in this report is a final budget for the workshop, along with a summary of the participants' evaluation of the workshop. The workshop proceeding have been delivered under separate cover. In order to assist in the organization of future workshops, we have also included in this report detailed documentation of the pre- and post-workshop activities associated with this contract. Specifically, we have included a section that documents the advertising performed, along with the manner in which applications were handled. A complete list of the workshop participants in this section. Sample letters that were generated while dealing with various commercial entities and departments at the University are also included in a section

dealing with workshop logistics. Finally, we have included a section in this report that deals with suggestions for future workshops.

31340 (LA-SUB–95-161) **Parallel computation of large least squares problems involving Kronecker products on the Connection Machine 5.** Fulton, C.T. (Florida Inst. of Tech., Melbourne, FL (United States). Dept. of Applied Mathematics); Wu, L. Los Alamos National Lab., NM (United States); Florida Inst. of Tech., Melbourne, FL (United States). Dept. of Applied Mathematics. Jul 1995. 4p. Sponsored by USDOE, Washington, DC (United States). DOE Contract W-7405-ENG-36. Contract 1030N0014-9H. Order Number DE96000858. Source: OSTI; NTIS; GPO Dep.

The authors present in this paper the implementation and some timing results for a Data Parallel Version of a Kronecker Product Least Squares Code on the Connection Machine 5.

31341 (LA-SUB–95-178) **Development of out-of-core fast Fourier transform software for the connection machine. Final report.** Sweet, R. (Univ. of Colorado, Denver, CO (United States). Center for Computational Mathematics); Wilson, J. Los Alamos National Lab., NM (United States); Colorado Univ., Denver, CO (United States). Center for Computational Mathematics. [1995]. 17p. Sponsored by USDOE, Washington, DC (United States). DOE Contract W-7405-ENG-36. Order Number DE96000857. Source: OSTI; NTIS; GPO Dep.

This report describes the algorithm and implementation of an out-of-core Fast Fourier Transform routine for the Thinking Machines Corp. CM-5 parallel computer. The software has the capability of transforming multi-dimensional arrays that are both real and complex.

31342 (LA-UR–95-906) **Towards heterogeneous distributed debugging.** Damodaran-Kamal, S.K. Los Alamos National Lab., NM (United States). [1995]. 30p. Sponsored by USDOE, Washington, DC (United States). DOE Contract W-7405-ENG-36. (CONF-951207–1: ACM/IEEE-CS supercomputing conference, San Diego, CA (United States), 4-8 Dec 1995). Order Number DE95009427. Source: OSTI; NTIS; GPO Dep.

Several years of research and development in parallel debugger design have given up several techniques, though implemented in a wide range of tools for an equally wide range of systems. This paper is an evaluation of these myriad techniques as applied to the design of a heterogeneous distributed debugger. The evaluation is based on what features users perceive as useful, as well as the ease of implementation of the features using the available technology. A preliminary architecture for such a heterogeneous tool is proposed. Our effort in this paper is significantly different from the other efforts at creating portable and heterogeneous distributed debuggers in that we concentrate on support for all the important issues in parallel debugging, instead of simply concentrating on portability and heterogeneity.

31343 (LA-UR–95-994) **High-speed connections for storage systems; HIPPI, fibre channel, and ATM: Whats happening?** Tolmie, D.E. Los Alamos National Lab., NM (United States). [1995]. 8p. Sponsored by USDOE, Washington, DC (United States). DOE Contract W-7405-ENG-36. (CONF-951207–4: ACM/IEEE-CS supercomputing conference, San Diego, CA (United States), 4-8 Dec 1995). Order Number DE95009415. Source: OSTI; NTIS; GPO Dep.

Contains article by D.E. Tolmie, A.G. Dornhoff, A.G. and A.J. DuBois: An ATM-based workstation cluster driving a HIPPI-based HDTV frame buffer.

A group of eight Digital Equipment Corporation Alpha workstations is interconnected with ATM to form a cluster with supercomputer power. For output, each workstation drives a single "tile" on an 8-tile high-resolution frame buffer. A special purpose adapter is used to convert the workstation's ATM format to the frame buffer's HIPPI format. This paper discusses the rationale behind the workstation farm, and then describes the visualization output path in detail. To provide the system quickly, special emphasis was placed on making the design as simple as possible. The design choices are examined, and the resultant system is described. The oral presentation will include operational experiences.

31344 (LA-UR–95-1108) **UNICORN: Misuse detection for UNICOS.** Christoph, G.G; Jackson, K.A.; Neuman, M.C.; Siciliano, C.L.B.; Simmonds, D.D.; Stallings, C.A.; Thompson, J.L. Los Alamos National Lab., NM (United States). 29 Mar 1995. 22p. Sponsored by USDOE, Washington, DC (United States). DOE Contract W-7405-ENG-36. (CONF-951207–3: ACM/IEEE-CS supercomputing conference, San Diego, CA (United States), 4-8 Dec 1995). Order Number DE95009488. Source: OSTI; NTIS; GPO Dep.

An effective method for detecting computer misuse is the automatic auditing and analysis of on-line user activity. This activity is reflected in the system audit record, by changes in the vulnerability posture of the system configuration, and in other evidence found through active testing of the system. In 1989 we started developing an automatic misuse detection system for the Integrated Computing Network (ICN) at Los Alamos National Laboratory. Since 1990 this system has been operational, monitoring a variety of network systems and services. We call it the Network Anomaly Detection and Intrusion Reporter, or NADIR. During the last year and a half, we expanded NADIR to include processing of audit and activity records for the Cray UNICOS operating system. This new component is called the UNICOS Real-time NADIR, or UNICORN. UNICORN summarizes user activity and system configuration information in statistical profiles. In near real-time, it can compare current activity to historical profiles and test activity against expert rules that express our security policy and define improper or suspicious behavior. It reports suspicious behavior to security auditors and provides tools to aid in follow-up investigations. UNICORN is currently operational on four Crays in Los Alamos' main computing network, the ICN.

31345 (LA-UR–95-1127) **Beyond the CM-5: A case study in performance analysis for the CM-5, T3D, and high performance RISC workstations.** Beazley, D.M. (Utah Univ., Salt Lake City, UT (United States). Dept. of Computer Science); Lomdahl, P.S. Los Alamos National Lab., NM (United States). 22 Mar 1995. 13p. Sponsored by USDOE, Washington, DC (United States);Institute of Electrical and Electronics Engineers, Inc., New York, NY (United States). DOE Contract W-7405-ENG-36. (CONF-951207–2: ACM/IEEE-CS supercomputing conference, San Diego, CA (United States), 4-8 Dec 1995). Order Number DE95009484. Source: OSTI; NTIS; GPO Dep.

We present a comprehensive performance evaluation of our molecular dynamics code SPaSM on the CM-5 in order to devise optimization strategies for the CM-5, T3D, and RISC workstations. In this analysis, we focus on the effective use of the SPARC microprocessor by performing measurements of instruction set utilization, cache effects, memory access patterns, and pipeline stall cycles. We then show that we can account for more than 99% of observed execution time of our program. Optimization strategies are devised and we show that our highly optimized ANSI C program running only on the SPARC microprocessor of the CM-5 is only twice as slow as our Gordon-Bell prize winning code that utilized the CM-5 vector units. On the CM-5E, we show that this optimized code run faster than the vector unit version. We then apply these techniques to the Cray T3D and measure resulting speedups. Finally, we show that simple optimization strategies are effective on a wide variety of high performance RISC workstations.

31346 (LA-UR–95-1296) **Wide-area Gigabit networking: Los Alamos HIPPI-SONET Gateway.** St. John, W.B.; DuBois, D.H. Los Alamos National Lab., NM (United States). [1995]. 9p. Sponsored by USDOE, Washington, DC (United States). DOE Contract W-7405-ENG-36. (CONF-951207–5: ACM/IEEE-CS supercomputing conference, San Diego, CA (United States), 4-8 Dec 1995). Order Number DE95010877. Source: OSTI; NTIS; GPO Dep.

This paper describes a HIPPI-SONET Gateway which has been designed by members of the Computer Network Engineering Group at Los Alamos National Laboratory. The Gateway has been used in the CASA Gigabit Testbed at Caltech, Los Alamos National Laboratory, and the San Diego Supercomputer Center to provide communications between the sites. This paper will also make some qualitative statements as to lessons learned during the deployment and maintenance of this wide area network. We report record throughput for transmission of data across a wide area network.

We have sustained data rates using the TCP/IP protocol of 550 Mbits/second and the rate of 792 Mbits/second for raw HIPPI data transfer over the 2,000 kilometers from the San Diego Supercomputer Center to the Los Alamos National Laboratory.

31347 (LA-UR–95-1766) **Parallel rendering techniques for massively parallel visualization.** Hansen, C.; Krogh, M.; Painter, J. Los Alamos National Lab., NM (United States). [1995]. 8p. Sponsored by USDOE, Washington, DC (United States). DOE Contract W-7405-ENG-36. (CONF-9507166–1: Graphicon '95, St. Petersburg (Russian Federation), 5-7 Jul 1995). Order Number DE95015317. Source: OSTI; NTIS; GPO Dep.

As the resolution of simulation models increases, scientific visualization algorithms which take advantage of the large memory. and parallelism of Massively Parallel Processors (MPPs) are becoming increasingly important. For large applications rendering on the MPP tends to be preferable to rendering on a graphics workstation due to the MPP's abundant resources: memory, disk, and numerous processors. The challenge becomes developing algorithms that can exploit these resources while minimizing overhead, typically communication costs. This paper will describe recent efforts in parallel rendering for polygonal primitives as well as parallel volumetric techniques. This paper presents rendering algorithms, developed for massively parallel processors (MPPs), for polygonal, spheres, and volumetric data. The polygon algorithm uses a data parallel approach whereas the sphere and volume render use a MIMD approach. Implementations for these algorithms are presented for the Thinking Ma.chines Corporation CM-5 MPP.

31348 (LA-UR–95-1823) **A neural computation approach to the set covering problem.** Grossman, T. Los Alamos National Lab.. NM (United States). [1995]. 8p. Sponsored by USDOE, Washington, DC (United States). DOE Contract W-7405-ENG-36. (CONF-9511123–1: Neural information processing systems, Denver, CO (United States), Nov 1995). Order Number DE95015316. Source: OSTI; NTIS; GPO Dep.

This paper presents a neural network algorithm which is capable of finding approximate solutions for unicost set covering problems. The network has two types of units (neurons), with different dynamics and activation functions. One type represents the objects to be covered (the rows in the matrix representation of the problem) and another represents the "covering" sets (the 0,1 variables). They are connected as a bipartite graph which represents the incidence relations between objects and sets (i.e the 0,1 adjacency matrix). When the parameters of the units are correctly tuned, the stable states of the system correspond to the minimal covers. I show that in its basic mode of operation, descent dynamics, when the network is set in an arbitrary initial state it converges in less than 2n steps (where n is the number of variables), to a stable state which represents a valid solution. In this mode, the network implements a greedy heuristic in which the choice function is based on the unit inputs (which are determined by the activation functions and the network state). On top of the basic network dynamics, the algorithm applies an adaptive restart procedure which helps to search more effectively for "good" initial states and results in better performance.

31349 (LA-UR–95-2836) **Quantum crytography over 14km of installed optical fiber.** Hughes, R.J.; Luther, G.G.; Morgan, G.L.; Simmons, C. Los Alamos National Lab., NM (United States). [1995]. 10p. Sponsored by Defense Nuclear Agency, Washington, DC (United States). DOE Contract W-7405-ENG-36. (CONF-9506238–2: 7. Rochester conference on coherence and quantum optics, Rochester, NY (United States), 7-10 Jun 1995). Order Number DE96000012. Source: OSTI; NTIS; GPO Dep.

We have made the first demonstration that low error rate quantum cryptography over long distances (14km) of installed optical fiber in a real-world environment, subject to uncontrolled temperature and mechanical influences, representing an important new step towards incorporation of quantum cryptography into existing information security systems. We also point out that the high visibility single-photon interference in our experiment allows us to infer a test of the superposition principle of quantum mechanics: a photon reaching the detector has traveled over 14km of optical fiber in a wavepacket comprising a coherent superposition of two components that are spatially separated by about 2m. In principle, there are decoherence processes (or even possible modifications of quantum mechanics) that could cause the photon's wavefunction to collapse into one component or the other during propagation, leading to a reduction in visibility. However, our results are consistent with no such loss of quantum coherence during the 67-μs propagation time.

31350 (LA-UR–95-2925) **Network improvement problems.** Krumke, S.O. (Univ. of Wuerzburg (Germany). Dept. of Computer Science); Noltemeier, H.; Drangmeister, K.U.; Marathe, M.V.; Ravi, S.S. Los Alamos National Lab., NM (United States). [1995]. 15p. Sponsored by USDOE, Washington, DC (United States). DOE Contract W-7405-ENG-36. (CONF-9501107–1: ACM symposium on discrete algorithms, Atlanta, GA (United States), Jan 1995). Order Number DE96000030. Source: OSTI; NTIS; GPO Dep.

The authors study budget constrained optimal network improvement problems. Such problems aim at finding optimal strategies for improving a network under some cost measure subject to certain budget constraints. As an example, consider the following prototypical problem: Let G = (V, E) be an undirected graph with two cost values L(e) and C(e) associated with each edge e, where L(e) denotes the length of e and C(e) denotes the cost of reducing the length of e by a unit amount. A reduction strategy specifies for each edge e, the amount by which L(e) is to be reduced. For a given budget B, the goal is to find a reduction strategy such that the total cost of reduction is at most B and the minimum cost tree (with respect to some measure M) under the modified L costs is the best over all possible reduction strategies which obey the budget constraint. Typical measures M for a tree are the total weight and the diameter. They provide both hardness and approximation results for the two measures M mentioned above. For the problem of minimizing the total weight of a spacing tree, they provide an algorithm that, for any fixed $\gamma, \varepsilon > 0$, finds a solution whose weight is at most $(1 + 1/\gamma)$ times that of a minimum length spanning tree plus an additive constant of at most ε and the total cost of improvement is at most $(1 + \gamma)$ times the budget B. This result can be extended to obtain approximation algorithms for more general network design problems considered in [GW, GG+94].

31351 (LA-UR–95-2971) **The ACL Message Passing Library.** Painter, J. (Los Alamos National Lab., NM (United States)); McCormick, P.; Krogh, M.; Hansen, C.; Colin de Verdiere, G. Los Alamos National Lab., NM (United States). [1995]. 10p. Sponsored by USDOE, Washington, DC (United States). DOE Contract W-7405-ENG-36. (CONF-9509231–1: European T3D workshop, Lausanne (Switzerland), 7 Sep 1995). Order Number DE96000021. Source: OSTI; NTIS; GPO Dep.

This paper presents the ACL (Advanced Computing Lab) Message Passing Library. It is a high throughput, low latency communications library, based on Thinking Machines Corp.'s CMMD, upon which message passing applications can be built. The library has been implemented on the Cray T3D, Thinking Machines CM-5, SGI workstations, and on top of PVM.

31352 (LA-UR–95-3222) **New analysis technique for K-edge densitometry spectra.** Hsue, Sin-Tao; Collins, M.L. Los Alamos National Lab., NM (United States). [1995]. 10p. Sponsored by USDOE, Washington, DC (United States). DOE Contract W-7405-ENG-36. (CONF-950923–9: 5. international conference on facility-safeguards interface, Jackson Hole, WY (United States), 24-30 Sep 1995). Order Number DE96001469. Source: OSTI; NTIS; INIS; GPO Dep.

A method for simulating absorption edge densitometry has been developed. This program enables one to simulate spectra containing any combination of special nuclear materials (SNM) in solution. The method has been validated with an analysis method using a single SNM in solution or a combination of two types of SNM separated by a Z of 2. A new analysis technique for mixed solutions has been developed. This new technique has broader applications and eliminates the need for bias correction.

31353 (LBL–36247) **Cautionary aphorisms for customer-oriented system development.** Stevens, D.F. (Lawrence Berkeley Lab., CA (United States). Information and Computing Sciences Div.). Lawrence Berkeley Lab., CA (United States). Oct 1994. 7p. Sponsored by USDOE, Washington, DC (United States). DOE

Contract AC03-76SF00098. (CONF-9502113–1: 1995 ACR conference on improving productivity in system development, Phoenix, AZ (United States), 6-10 Feb 1995). Order Number DE95006575. Source: OSTI; NTIS; GPO Dep.

Of the three substantive two-word clusters in the title of this note the least important is system development. Although people who attend conferences like this may be interested in system development, few other people are. Customers, in particular, are much more interested in system use, system availability, and system effectiveness, than in system development. Because it is the customers who keep one in business, it therefore behooves one to develop some techniques to keep use, availability, and effectiveness in mind–in other words, to develop a customer orientation. This note illustrates one such technique: the distillation of applicable wisdom concerning people, systems, and the relationships between them into statements made memorable by their wit, brevity, and pungency. In this session the author hopes to start one on the way to one's own collection of useful thoughts. It should be noted that the preparation of such a collection serves as a working demonstration of the value of re-use as a productivity principle: few of these statements are original with him, and many had origins in other applications. He considers in turn methodology and procedure, design, schedules, measurement, documentation, and quality.

31354 (LBL–36540) **Taking an object-oriented view of accelerators.** Nishimura, H. Lawrence Berkeley Lab., CA (United States). Apr 1995. 5p. Sponsored by USDOE, Washington, DC (United States). DOE Contract AC03-76SF00098. (LSGN–214; CONF-950512–321: Particle accelerator conference, Dallas, TX (United States), 1-5 May 1995). Order Number DE96000144. Source: OSTI; NTIS; GPO Dep.

It was almost a decade ago that accelerator experts were introduced to the concept of object-oriented programming. This new methodology was expected to play a key role in solving various software problems. Today, there seems be nothing that prevents us from taking advantage of this new technology. In fact, we are often forced to catch up with the computer industry's new standards. This is especially true for graphics programming. While evaluating the benefits of using this new technology, we must also evaluate whether it is as effective as it was claimed. In this paper, we discuss these issues based on experiences at the Advanced Light Source.

31355 (LBL–36775) **Methods of constructing a 3D geological model from scatter data.** Horsman, J.; Bethel, W. Lawrence Berkeley Lab., CA (United States). Apr 1995. 13p. Sponsored by USDOE, Washington, DC (United States). DOE Contract AC03-76SF00098. (CONF-9504204–1: Advanced visual systems conference, Boston, MA (United States), 19-21 Apr 1995). Order Number DE96000131. Source: OSTI; NTIS; GPO Dep.

Most geoscience applications, such as assessment of an oil reservoir or hazardous waste site, require geological characterization of the site. Geological characterization involves analysis of spatial distributions of lithology, porosity, etc. Because of the complexity of the spatial relationships, the authors find that a 3-D model of geology is better suited for integration of many different types of data and provides a better representation of a site than a 2-D one. A 3-D model of geology is constructed from sample data obtained from field measurements, which are usually scattered. To create a volume model from scattered data, interpolation between points is required. The interpolation can be computed using one of several computational algorithms. Alternatively, a manual method may be employed, in which an interactive graphics device is used to input by hand the information that lies between the data points. For example, a mouse can be used to draw lines connecting data points with equal values. The combination of these two methods presents yet another approach. In this study, the authors will compare selected methods of 3-D geological modeling. They used a flow-based, modular visualization environment (AVS) to construct the geological models computationally. Within this system, they used three modules, scat_3d, trivar and scatter_to_ucd, as examples of computational methods. They compare these methods to the combined manual and computational approach. Because there are no tools readily available in AVS for this type of construction, they used a geological modeling system to demonstrate this method.

31356 (LBL–37200, pp. 90-95) **A graphical interface to the TOUGH family of flow simulators.** O'Sullivan, M.J. (Univ. of Auckland (New Zealand)); Bullivant, D.P. Lawrence Berkeley Lab., CA (United States). Mar 1995. DOE Contract AC03-76SF00098. (CONF-9503110–: TOUGH 95: transport of unsaturated ground water and heat workshop, Berkeley, CA (United States), 20-22 Mar 1995). In *Proceedings of the TOUGH Workshop '95 Lawrence Berkeley Laboratory, Berkeley, California, March 20–22, 1995.* 380p. Order Number DE95014788. Source: OSTI; NTIS; GPO Dep.

A graphical interface for the TOUGH family of simulators is presented. The interface allows the user to graphically create or modify a computer model and then to graphically examine the simulation results. The package uses the X Window System, enabling it to be used on many computer platforms.

31357 (LBL–37200, pp. 265-270) **Use of TOUGH2 on small computers.** Antunez, E. (Lawrence Berkeley Laboratory, CA (United States)); Pruess, K.; Moridis, G. Lawrence Berkeley Lab., CA (United States). Mar 1995. DOE Contract AC03-76SF00098. (CONF-9503110–: TOUGH 95: transport of unsaturated ground water and heat workshop, Berkeley, CA (United States), 20-22 Mar 1995). In *Proceedings of the TOUGH Workshop '95 Lawrence Berkeley Laboratory, Berkeley, California, March 20–22, 1995.* 380p. Order Number DE95014788. Source: OSTI; NTIS; GPO Dep.

TOUGH2/PC has been tested extensively on different PC platforms (486-33, 486-66, Pentium-90), with encouraging results. TOUGH2 performance has also been tested in other 32-bit computers as the MacIntosh Quadra 800, and a workstation IBM RISC 6000. Results obtained with these machines are compared with PCs' performance. PC results for 3-D geothermal reservoir models are discussed, including: (a) a Cartesian; and (b) a geothermal reservoir model with 1,411 irregular grid blocks. Also discussed are the results of the TOUGH2-compiler performance tests conducted on small computer systems. Code modifications required to operate on 32-bit computers and its setup in each machine environment are described. It is concluded that in today's market PCs provide the best price/performance alternative to conduct TOUGH2 numerical simulations.

31358 (LBL–37200, pp. 271-276) **Graphical user interface for TOUGH/TOUGH2 - development of database, pre-processor, and post-processor.** Sato, Tatsuya (Geothermal Energy Research and Development Co., Ltd., Tokyo (Japan)); Okabe, Takashi; Osato, Kazumi. Lawrence Berkeley Lab., CA (United States). Mar 1995. DOE Contract AC03-76SF00098. (CONF-9503110–: TOUGH 95: transport of unsaturated ground water and heat workshop, Berkeley, CA (United States), 20-22 Mar 1995). In *Proceedings of the TOUGH Workshop '95 Lawrence Berkeley Laboratory, Berkeley, California, March 20–22, 1995.* 380p. Order Number DE95014788. Source: OSTI; NTIS; GPO Dep.

One of the advantages of the TOUGH/TOUGH2 (Pruess, 1987 and 1991) is the modeling using "free shape" polygonal blocks. However, the treatment of three-dimensional information, particularly for TOUGH/TOUGH2 is not easy because of the "free shape" polygonal blocks. Therefore, we have developed a database named "GEOBASE" and a pre/post-processor named "GEOGRAPH" for TOUGH/TOUGH2 on engineering work station (EWS). "GEOGRAPH" is based on the ORACLE* relational database manager system to access data sets of surface exploration (geology, geophysics, geochemistry, etc.), drilling (well trajectory, geological column, logging, etc.), well testing (production test, injection test, interference test, tracer test, etc.) and production/injection history."GEOGRAPH" consists of "Pre-processor" that can construct the three-dimensional free shape reservoir modeling by mouse operation on X-window and "Post-processor" that can display several kinds of two/three-dimensional maps and X-Y plots to compile data on "GEOBASE" and result of TOUGH/TOUGH2 calculation. This paper shows concept of the systems and examples of utilization.

31359 (LBL–37200, pp. 277-280) **Energy Science and Technology Software Center.** Kidd, E.M. Lawrence Berkeley Lab., CA (United States). Mar 1995. DOE Contract AC03-76SF00098. (CONF-9503110–: TOUGH 95: transport of unsaturated ground

water and heat workshop, Berkeley, CA (United States), 20-22 Mar 1995). In *Proceedings of the TOUGH Workshop '95 Lawrence Berkeley Laboratory, Berkeley, California, March 20–22, 1995.* 380p. Order Number DE95014788. Source: OSTI; NTIS; GPO Dep.

The Energy Science and Technology Software Center (ESTSC), is the U.S. Department of Energy's (DOE) centralized software management facility. It is operated under contract for the DOE Office of Scientific and Technical Information (OSTI) and is located in Oak Ridge, Tennessee. The ESTSC is authorized by DOE and the U.S. Nuclear Regulatory Commission (NRC) to license and distribute DOE-and NRC-sponsored software developed by national laboratories and other facilities and by contractors of DOE and NRC. ESTSC also has selected software from the Nuclear Energy Agency (NEA) of the Organisation for Economic Cooperation and Development (OECD) through a software exchange agreement that DOE has with the agency.

31360 (LBL–37200, pp. 281-286) **Experiences using multigrid for geothermal simulation.** Bullivant, D.P. (Univ. of Auckland (New Zealand)); O'Sullivan, M.J.; Yang, Z. Lawrence Berkeley Lab., CA (United States). Mar 1995. DOE Contract AC03-76SF00098. (CONF-9503110–: TOUGH 95: transport of unsaturated ground water and heat workshop, Berkeley, CA (United States), 20-22 Mar 1995). In *Proceedings of the TOUGH Workshop '95 Lawrence Berkeley Laboratory, Berkeley, California, March 20–22, 1995.* 380p. Order Number DE95014788. Source: OSTI; NTIS; GPO Dep.

Experiences of applying multigrid to the calculation of natural states for geothermal simulations are discussed. The modelling of natural states was chosen for this study because they can take a long time to compute and the computation is often dominated by the development of phase change boundaries that take up a small region in the simulation. For the first part of this work a modified version of TOUGH was used for 2-D vertical problems. A "test-bed" program is now being used to investigate some of the problems encountered with implementing multigrid. This is ongoing work. To date, there have been some encouraging but not startling results.

31361 (LBL–37200, pp. 299-304) **Diomres (k,m): An efficient method based on Krylov subspaces to solve big, dispersed, unsymmetrical linear systems.** de la Torre Vega, E. (Instituto de Investigaciones Electricas, Cuernavaca (Mexico)); Cesar Suarez Arriaga, M. Lawrence Berkeley Lab., CA (United States). Mar 1995. DOE Contract AC03-76SF00098. (CONF-9503110–: TOUGH 95: transport of unsaturated ground water and heat workshop, Berkeley, CA (United States), 20-22 Mar 1995). In *Proceedings of the TOUGH Workshop '95 Lawrence Berkeley Laboratory, Berkeley, California, March 20–22, 1995.* 380p. Order Number DE95014788. Source: OSTI; NTIS; GPO Dep.

In geothermal simulation processes, MULKOM uses Integrated Finite Differences to solve the corresponding partial differential equations. This method requires to resolve efficiently big linear dispersed systems of non-symmetrical nature on each temporal iteration. The order of the system is usually greater than one thousand its solution could represent around 80% of CPU total calculation time. If the elapsed time solving this class of linear systems is reduced, the duration of numerical simulation decreases notably. When the matrix is big ($N \geq 500$) and with holes, it is inefficient to handle all the system's elements, because it is perfectly figured out by its elements distinct of zero, quantity greatly minor than N^2. In this area, iteration methods introduce advantages with respect to gaussian elimination methods, because these last replenish matrices not having any special distribution of their nonzero elements and because they do not make use of the available solution estimations. The iterating methods of the Conjugated Gradient family, based on the subspaces of Krylov, possess the advantage of improving the convergence speed by means of preconditioning techniques. The creation of DIOMRES(k,m) method guarantees the continuous descent of the residual norm, without incurring in division by zero. This technique converges at most in N iterations if the system's matrix is symmetrical, it does not employ too much memory to converge and updates immediately the approximation by using incomplete orthogonalization and adequate restarting. A preconditioned version of DIOMRES was applied to problems related to unsymmetrical systems with 1000 unknowns and less than five terms per equation. We found that this technique could reduce notably the time needful to find the solution without requiring memory increment. The coupling of this method to geothermal versions of MULKOM is in process.

31362 (NEDO-IT–9301) **Investigation of the human interface related technology. 2.** New Energy and Industrial Technology Development Organization, Tokyo (Japan). Mar 1994. 117p. (In Japanese). Sponsored by New Energy and Industrial Technology Development Organization, Tokyo (Japan). Order Number DE96704375. Source: OSTI; NTIS; Available from New Energy and Industrial Technology Development Organization, Sunshine 60, 30F 1-1, 3-chome, Higashi-Ikebukuro, Toshima-ku, Tokyo, Japan.

For the purpose of examining how to cope with the virtual reality (VR) technology which constitutes a new basic technology, investigations were made to study research and development centering about the U.S. and to consider its future. The contents are broken down by technological fields of involving research and development, to reveal that items covering the generation of artificial space or interfaces with man are particularly large in number, occupying 20 to 30 percent. The second largest are the number of items dealing with robot-aided generation of artificial space, occupying approximately 15 percent. The field of the explication of man, remarkably featuring the VR studies in the U.S., and occupies 14 percent. Research and development regarding artificial space sharing is in progress surefootedly although there is some difference between Japan and the U.S. in approaching the task. As for alignment between artificial spaces in the U.S., in many cases it is studied in relation to telerobotics. It has been concluded that VR is a natural human interface, so natural that it is not detected even when it is in use, and that every one of our acts in the future can be an object of VR. 9 figs., 10 tabs.

31363 (NIFS–341) **A new algorithm for differential-algebraic equations based on HIDM.** Watanabe, Tsuguhiro; Gnudi, G. National Inst. for Fusion Science, Nagoya (Japan). Feb 1995. 27p. Order Number DE96701294. Source: OSTI; NTIS; INIS.

A new algorithm is proposed to solve differential-algebraic equations. The algorithm is an extension of the algorithm of general purpose HIDM (higher order implicit difference method). A computer program named HDMTDV and based on the new algorithm is constructed and its high performance is proved numerically through several numerical computations, including index-2 problem of differential-algebraic equations and connected rigid pendulum equations. The new algorithm is also secular error free when applied to dissipationless dynamical systems. This nature is demonstrated numerically by computation of the Kepler motion. The new code can solve the initial value problem $O = L \{ \phi(x), [d\phi(x)]/dx, [d^2\phi(x)]/dx^2, x \}$, where L and ϕ are vectors of length N. The values of first or second derivatives of $\phi(x)$ are not always necessary in the equations. (author).

31364 (ORNL/TM–12811) **Experiences in effective use of Tcl/Tk.** Lee, R.W. Oak Ridge National Lab., TN (United States). Jun 1995. 100p. Sponsored by USDOE, Washington, DC (United States). DOE Contract AC05-84OR21400. Order Number DE95017198. Source: OSTI; NTIS; GPO Dep.

Tcl/Tk (Toot Command Language and Tool Kit, pronounced "tickle tee-kay") is a scripting language supporting Motifm style X Window interfaces. It is extendible, allowing developers to embed additional functionality as commands in the language. However, the power and flexibility of the system leads to many variations or possibilities in its usage. We describe effective methods for taking advantage of Tcl/Tk to increase productivity and enhance the flexibility and adaptability of applications: writing simple Tcl/Tk scripts, extending the Tcl/Tk widget set, wrapping Tcl commands around existing classes and functions, and building Tcl/Tk and 3GL coprocesses. Examples are presented from working applications.

31365 (ORNL/TM–12986) **Performance of parallel computers for spectral atmospheric models.** Foster, I.T. (Argonne National Lab., IL (United States)); Toonen, B.; Worley, P.H. Oak Ridge National Lab., TN (United States). Jun 1995. 33p. Sponsored by USDOE, Washington, DC (United States). DOE Contract AC05-84OR21400. Order Number DE95017310. Source: OSTI; NTIS; GPO Dep.

Massively parallel processing (MPP) computer systems use high-speed interconnection networks to link hundreds or thousands of RISC microprocessors. With each microprocessor having a peak performance of 100 Mflops/sec or more, there is at least the possibility of achieving very high performance. However, the question of exactly how to achieve this performance remains unanswered. MPP systems and vector multiprocessors require very different coding styles. Different MPP systems have widely varying architectures and performance characteristics. For most problems, a range of different parallel algorithms is possible, again with varying performance characteristics. In this paper, we provide a detailed, fair evaluation of MPP performance for a weather and climate modeling application. Using a specially designed spectral transform code, we study performance on three different MPP systems: Intel Paragon, IBM SP2, and Cray T3D. We take great care to control for performance differences due to varying algorithmic characteristics. The results yield insights into MPP performance characteristics, parallel spectral transform algorithms, and coding style for MPP systems. We conclude that it is possible to construct parallel models that achieve multi-Gflop/sec performance on a range of MPPs if the models are constructed to allow run-time selection of appropriate algorithms.

31366 (ORNL/TM–12999) **Redistribution of block-cyclic data distributions using MPI.** WSalker, D.W. (Oak Ridge National Lab., TN (United States)); Otto, S.W. Oak Ridge National Lab., TN (United States). Jun 1995. 29p. Sponsored by Department of the Army, Washington, DC (United States);National Science Foundation, Washington, DC (United States). DOE Contract AC05-84OR21400. DAAL03-91-C-0047; ASC-ASC-9005933. Order Number DE95017191. Source: OSTI; NTIS; GPO Dep.

Arrays that are distributed in a block cyclic fashion are important for many applications in the computational sciences since they often lead to parallel algorithms with good load balancing properties. We consider the problem of redistributing such an array to a new block size. This operation is directly expressible in High Performance Fortran (HPF) and will arise in applications written in this language. Efficient message passing algorithms are given for the redistribution operation, expressed in the standardized message passing interface, MPI. The algorithms are analyzed and performance results from the IBM SP-1 and Intel Paragon are given and discussed. The results show that redistribution can be done in time comparable to other collective communication operations, such as broadcast and MPI_ALLTOALL.

31367 (ORNL/TM–13060) **2-D image segmentation using minimum spanning trees.** Xu, Y.; Uberbacher, E.C. Oak Ridge National Lab., TN (United States). Sep 1995. 22p. Sponsored by USDOE, Washington, DC (United States). DOE Contract AC05-84OR21400. Order Number DE96000838. Source: OSTI; NTIS; GPO Dep.

This paper presents a new algorithm for partitioning a gray-level image into connected homogeneous regions. The novelty of this algorithm lies in the fact that by constructing a minimum spanning tree representation of a gray-level image, it reduces a region partitioning problem to a minimum spanning tree partitioning problem, and hence reduces the computational complexity of the region partitioning problem. The tree-partitioning algorithm, in essence, partitions a minimum spanning tree into subtrees, representing different homogeneous regions, by minimizing the sum of variations of gray levels over all subtrees under the constraints that each subtree should have at least a specified number of nodes, and two adjacent subtrees should have significantly different average gray-levels. Two (faster) heuristic implementations are also given for large-scale region partitioning problems. Test results have shown that the segmentation results are satisfactory and insensitive to noise.

31368 (SAND–95-0471C) **Emissive flat panel displays: A challenge to the AMLCD.** Walko, R.J. Sandia National Labs., Albuquerque, NM (United States). [1995]. 4p. Sponsored by USDOE, Washington, DC (United States). DOE Contract AC04-94AL85000. (CONF-951033–8: 27. international technical conference of the Society for the Advancement of Material and Process Engineering (SAMPE): diversity into the next century, Albuquerque, NM (United States), 9-12 Oct 1995). Order Number DE95015081. Source: OSTI; NTIS; GPO Dep.

According to some sources, flat panel displays (FPDS) for computers will represent a $20-40B industry by the end of the decade and could leverage up to $100-200B in computer sales. Control of the flat panel display industry could be a significant factor in the global economy if FPDs manage to tap into the enormous audio/visual consumer market. Japan presently leads the world in active matrix liquid crystal display (AMLCD) manufacturing, the current leading FPD technology. The AMLCD is basically a light shutter which does not emit light on its own, but modulates the intensity of a separate backlight. However, other technologies, based on light emitting phosphors, could eventually challenge the @CD's lead position. These light-emissive technologies do not have the size, temperature and viewing angle limitations of AMLCDS. In addition, they could also be less expensive to manufacture, and require a smaller capital outlay for a manufacturing plant. An overview of these alternative technologies is presented.

31369 (SAND–95-1094C) **Using singular value decomposition to compute the conditioned cross-spectral density matrix and coherence functions.** Smallwood, D.O. Sandia National Labs., Albuquerque, NM (United States). 7 Aug 1995. 10p. Sponsored by USDOE, Washington, DC (United States). DOE Contract AC04-94AL85000. (CONF-9510195–3: 66. shock and vibration symposium, Biloxi, MS (United States), 31 Oct - 3 nov 1995). Order Number DE95016743. Source: OSTI; NTIS; GPO Dep.

It is shown that the usual method for computing the coherence functions (ordinary, partial, and multiple) for a general multiple-input/multiple-output problem can be expressed as a modified form of Cholesky decomposition of the cross spectral density matrix of the inputs and outputs. The modified form of Cholesky decomposition used is $G_{zz} = LCL'$, where G is the cross spectral density matrix of inputs and outputs, L is a lower; triangular matrix with ones on the diagonal, and C is a diagonal matrix, and the symbol ' denotes the conjugate transpose. If a diagonal element of C is zero, the off diagonal elements in the corresponding column of L are set to zero. It is shown that the results can be equivalently obtained using singular value decomposition (SVD) of G_{zz}. The formulation as a SVD problem suggests a way to order the inputs when a natural physical order of the inputs is absent.

31370 (SAND–95-1234C) **Understanding and managing risk in software systems.** Fletcher, S.K.; Jansma, R.; Lim, J.; Murphy, M.; Wyss, G. Sandia National Labs., Albuquerque, NM (United States). [1995]. 9p. Sponsored by USDOE, Washington, DC (United States). DOE Contract AC04-94AL85000. (CONF-951236–1: Computer security applications conference, New Orleans, LA (Luxembourg), 11-15 Dec 1995). Order Number DE95013833. Source: OSTI; NTIS; GPO Dep.

When software is used in safety-critical, security-critical, or mission-critical situations, it is imperative to understand and manage the risks involved. A risk assessment methodology and toolset have been developed which are specific to software systems. This paper describes the concepts of the methodology, with emphasis on the experience of designing a toolset to support the methodology. Also presented are results of applying the methodology to two real software-based products: the software toolset itself, and a network firewall.

31371 (SAND–95-1901C) **Application of the bootstrap to the analysis of vibration test data.** Hunter, N.F. (Los Alamos National Lab., NM (United States)); Paez, T.L. Sandia National Labs., Albuquerque, NM (United States). [1995]. 10p. Sponsored by USDOE, Washington, DC (United States). DOE Contract AC04-94AL85000. (CONF-9510195–1: 66. shock and vibration symposium, Biloxi, MS (United States), 31 Oct - 3 nov 1995). Order Number DE95016742. Source: OSTI; NTIS; GPO Dep.

Structural dynamic testing is concerned with estimation of system properties, including frequency response functions and modal characteristics. These properties are derived from tests on the structure of interest, during which excitations and responses are measured and Fourier techniques are used to reduce the data. The inputs used in a test are frequently radom and excite random responses in the structure of interest. When these random inputs

and responses are analyzed they yield estimates of system properties that are random variable and random process realizations. Of course, such estimates of system properties vary randomly from one test to another, but even when deterministic inputs are used to excite a structure, the estimated properties vary from test to test. When test excitations and responses are normally distributed, classical techniques permit us to statistically analyze inputs, responses, and system parameters. However, when the input excitations are non-normal, the system is nonlinear, and/or the property of interest is anything but the simplest, the classical analyses break down. The bootstrap is a technique for the statistical analysis of data that are not necessarily normally distributed. It can be used to statistically analyze any measure of input excitation on response, or any system property, when data are available to make an estimate. It is designed to estimate the standard error, bias, and confidence intervals of parameter estimates. This paper shows how the bootstrap can be applied to the statistical analysis of modal parameters.

31372 (SAND–95-2134C) **Scalable end-to-end ATM encryption test results.** Pierson, L.G. Sandia National Labs., Albuquerque, NM (United States). [1995]. 6p. Sponsored by USDOE, Washington, DC (United States). DOE Contract AC04-94AL85000. (CONF-9509232–1: Cray user group meeting, Fairbanks, AK (United States), 25-29 Sep 1995). Order Number DE96000723. Source: OSTI; NTIS; GPO Dep.

Customers of Asynchronous Transfer Mode (ATM) services may need a variety of data authenticity and privacy assurances. Cryptographic methods can be used to assure authenticity and privacy, but are hard to scale for implementation at high speed. The incorporation of these methods into computer networks can severely impact functionality, reliability, and performance. To study these trade-offs, a prototype encryptor/decryptor was developed. This effort demonstrated the viability of implementing certain encryption techniques in high speed networks. The research prototype processes ATM cells in a SONET OC-3 payload. This paper describes the functionality, reliability, security, and performance design tradeoffs investigated with the prototype.

31373 (SAND–95-2195C) **High performance computing at Sandia National Labs.** Cahoon, R.M.; Noe, J.P.; Vandevender, W.H. Sandia National Labs., Albuquerque, NM (United States). [1995]. 4p. Sponsored by USDOE, Washington, DC (United States). DOE Contract AC04-94AL85000. (CONF-9509232–2: Cray user group meeting, Fairbanks, AK (United States), 25-29 Sep 1995). Order Number DE96000719. Source: OSTI; NTIS; GPO Dep.

Sandia's High Performance Computing Environment requires a hierarchy of resources ranging from desktop, to department, to centralized, and finally to very high-end corporate resources capable of teraflop performance linked via high-capacity Asynchronous Transfer Mode (ATM) networks. The mission of the Scientific Computing Systems Department is to provide the support infrastructure for an integrated corporate scientific computing environment that will meet Sandia's needs in high-performance and midrange computing, network storage, operational support tools, and systems management. This paper describes current efforts at SNL/NM to expand and modernize centralized computing resources in support of this mission.

31374 (SAND–95-2245C) **Power as a function of reliability.** Abate, M.L. (Sandia National Labs., Albuquerque, NM (United States)); McCabe, G.P.; Lynch, M.P. Sandia National Labs., Albuquerque, NM (United States). [1995]. 5p. Sponsored by USDOE, Washington, DC (United States). DOE Contract AC04-94AL85000. (CONF-9508165–2: Joint statistical meetings, Orlando, FL (United States), 13-17 Aug 1995). Order Number DE96000685. Source: OSTI; NTIS; GPO Dep.

Many studies employ multiple measurement instruments such as human raters, observers, judges, or mechanical gauges to record subject data. It is well known that the consistency of these instruments, commonly called rater reliability, limits the extent to which conclusions should be drawn from the observed data. However, the degree to which rater reliability limits conclusions has traditionally been assessed in only subjective manners. In this paper, a method is developed for objectively quantifying the impact of rate reliability on the statistical analysis of data from a commonly used collection scheme. This method allows the inclusion of a reliability index in statistical power calculations and is an invaluable tool in the planning of experiments.

31375 (SLAC-PUB–95-6744) **Network management and performance monitoring at SLAC.** Logg, C.A.; Cottrell, R.L.A. Stanford Linear Accelerator Center, Menlo Park, CA (United States). [1995]. 7p. Sponsored by USDOE, Washington, DC (United States). DOE Contract AC03-76SF00515. (CONF-9503103–2: NetWorld and Interop '95, Las Vegas, NV (United States), 27-29 Mar 1995). Order Number DE95016511. Source: OSTI; NTIS; GPO Dep.

The physical network plant and everything attached to it, including the software running on "computers" and other peripheral devices is the **system**. Subjectively, the ultimate measurers of **system** performance are the users and their perceptions of the performance of their networked applications. The performance of a **system** is affected by the physical network plant (routers, bridges, hubs, etc.) as well as by every "computer" and peripheral device that is attached to it, and the software running on the computers and devices. Performance monitoring of a network must therefore include computer systems and services monitoring as well as monitoring of the physical network plant. This paper will describe how this challenge has been tackled at SLAC, and how, via the World Wide Web, this information is made available for quick perusal by concerned personnel and users.

31376 (UCRL-ID–114972-2, pp. 4, Paper 2) **Evaluating the ISDN line to deliver interactive multimedia experiences.** Michaels, D.K. (New Jersey Institute of Technology, NJ (United States)). Lawrence Livermore National Lab., CA (United States). 6 May 1994. DOE Contract W-7405-ENG-48. (CONF-9405328–Absts.: Science and Engineering Research Semester (SERS) student symposium, Livermore, CA (United States), 6 May 1994). In *SERS intership: Spring 1994 abstracts and research papers.* 195p. Order Number DE95014118. Source: OSTI; NTIS; GPO Dep.

We will use the 128 kilobit/sec ISDN connection from the Lawrence Livermore National Laboratory to the Livermore High School Math Learning Center to provide students there with interactive multimedia educational experiences. These experiences may consist of tutorials, exercises, and interactive puzzles to teach students' course material. We will determine if it is possible to store the multimedia files at LLNL and deliver them to the student machines via FTP as they are needed. An evaluation of the effect of the ISDN data rate is a substantial component of our research and suggestions on how to best use the ISDN line in this capacity will be given.

31377 (UCRL-ID–114972-2, pp. 9, Paper 12) **Creating an automated tool for measuring software cohesion.** Tutton, J.M. (California State Univ., Sacramento, CA (United States)); Zucconi, L. Lawrence Livermore National Lab., CA (United States). 6 May 1994. (CONF-9405328–Absts.: Science and Engineering Research Semester (SERS) student symposium, Livermore, CA (United States), 6 May 1994). In *SERS intership: Spring 1994 abstracts and research papers.* 195p. Order Number DE95014118. Source: OSTI; NTIS; GPO Dep.

Program modules with high complexity tend to be more error prone and more difficult to understand. These factors increase maintenance and enhancement costs. Hence, a tool that can help programmers determine a key factor in module complexity should be very useful. Our goal is to create a software tool that will automatically give a quantitative measure of the cohesiveness of a given module, and hence give us an estimate of the "maintainability" of that module. The Tool will use a metric developed by Professors Linda M. Ott and James M. Bieman. The Ott/Bieman metric gives quantitative measures that indicate the degree of functional cohesion using abstract data slices.

31378 (UCRL-ID–114972-2, pp. 14, Paper 9) **Genetic algorithms using SISAL parallel programming language.** Tejada, S. Lawrence Livermore National Lab., CA (United States). 6 May 1994. (CONF-9405328–Absts.: Science and Engineering Research Semester (SERS) student symposium, Livermore, CA (United States), 6 May 1994). In *SERS intership: Spring 1994 abstracts and research papers.* 195p. Order Number DE95014118. Source: OSTI; NTIS; GPO Dep.

Genetic algorithms are a mathematical optimization technique developed by John Holland at the University of Michigan [1]. The SISAL programming language possesses many of the characteristics desired to implement genetic algorithms. SISAL is a deterministic, functional programming language which is inherently parallel. Because SISAL is functional and based on mathematical concepts, genetic algorithms can be efficiently translated into the language. Several of the steps involved in genetic algorithms, such as mutation, crossover, and fitness evaluation, can be parallelized using SISAL. In this paper I will I discuss the implementation and performance of parallel genetic algorithms in SISAL.

31379 (UCRL-ID–119453) **Progress in sub-grid scale modeling of shock-turbulence interaction.** Buckingham, A.C. (Lawrence Livermore National Lab., CA (United States). Center for Advanced Fluid Dynamics Applications); Grun, J. Lawrence Livermore National Lab., CA (United States). Dec 1994. 11p. Sponsored by USDOE, Washington, DC (United States). DOE Contract W-7405-ENG-48. Order Number DE95017859. Source: OSTI; NTIS; GPO Dep.

The authors report on progress in the development of sub grid scale (SGS) closure relationships for the unresolved motion scales in compressible large eddy simulations (LES). At present they are refining the SGS model and overall LES procedure to include: a linearized viscoelastic model for finite thickness shock distortions and shocked turbulence field response; multiple scale asymptotic considerations to improve predictions of average near-wall surface behavior; and a spectral statistical model simulating the effects of high wave number stochastic feed-back from the unresolved SGS nonlinear motion influences on the explicitly resolved grid scale motions. Predicted amplification levels, modal energy partition, shock translational to turbulence kinetic energy transfer, and viscoelastic spatio-temporal response of turbulence to shock interaction are examined in comparison with available experimental evidence. Supplemental hypersonic compressible turbulence experimental information is developed from sub nanosecond interval pulsed shadowgraph evidence of laser impulse generated hypervelocity shocks interacting with intense, previously developed and carefully characterized initial turbulence. Accurate description of the influence of shock-turbulence interactions is vital for predicting their influence on: Supersonic/hypersonic flow field analysis, aerodynamic design, and aerostructural materials selection. Practical applications also include interior supersonic combustion analysis and combustion chamber design. It is also the essential foundation for accurately predicting the development and evolution of flow-field generated thermal and electromagnetic radiation important to hypersonic flight vehicle survivability, detection and communication.

31380 (UCRL-ID–120900) **Simulation of phase structures.** Lawson, J. Lawrence Livermore National Lab., CA (United States). 20 Apr 1995. 8p. Sponsored by USDOE, Washington, DC (United States). DOE Contract W-7405-ENG-48. Order Number DE96000330. Source: OSTI; NTIS; INIS; GPO Dep.

This memo outlines a procedure developed by the author to extract information from phase measurements and produce a simulated phase structure for use in modeling optical systems, including characteristic optics for the Beamlet and NIF laser systems. The report includes an IDL program listing.

31381 (UCRL-ID–121523) **A status report on the development of SAC2000: A new seismic analysis code.** Goldstein, P.; Minner, L. Lawrence Livermore National Lab., CA (United States). Aug 1995. 20p. Sponsored by USDOE, Washington, DC (United States). DOE Contract W-7405-ENG-48. Order Number DE96000329. Source: OSTI; NTIS; GPO Dep.

We are developing a new Seismic Analysis Code (SAC2000) that will meet the research needs of the seismic research and treaty monitoring communities. Our first step in this development was to rewrite the original Seismic Analysis Code (SAC) – a Fortran code that was approximately 140,000 lines long – in the C programming language. This rewrite has resulted in a much more robust code that is faster, more efficient, and more portable than the original. We have implemented important processing capabilities such as convolution and binary monograms, and we have significantly enhanced several previously existing capabilities. For example, the spectrogram command now produces a correctly registered plot of the input time series and a color image of the output spectrogram. We have also added an image plotting capability with access to 17 predefined color tables or custom color tables. A rewritten version of the readcss command can now be used to access any of the documented css.3.0 database data formats, a capability that is particularly important to the Air Force Technical Applications Center (AFTAC) and the monitoring community. A much less visible, but extremely important contribution is the correction of numerous inconsistencies and errors that have evolved because of piecemeal development and limited maintenance since SAC was first written. We have also incorporated on-line documentation and have made SAC documentation available on the Internet via the world-wide-web at http://www-ep/tvp/sac.html.

31382 (UCRL-JC–119752) **Performance of a neutron transport code with full phase space decomposition on the Cray Research T3D.** Dorr, M.R.; Salo, E.M. Lawrence Livermore National Lab., CA (United States). Jan 1995. 10p. Sponsored by USDOE, Washington, DC (United States). DOE Contract W-7405-ENG-48. (CONF-950420–32: International conference on mathematics and computations, reactor physics, and environmental analyses, Portland, OR (United States), 30 Apr - 4 may 1995). Order Number DE96000335. Source: OSTI; NTIS; INIS; GPO Dep.

We present performance results obtained on a 128-node Cray Research T3D computer by a neutron transport code implementing a standard mtiltigroup, discrete ordinates algorithm on a three-dimensional Cartesian grid. After summarizing the implementation strategy used to obtain a full decomposition of phase space (i.e., simultaneous parallelization of the neutron energy, directional and spatial variables), we investigate the scalability of the fundamental source iteration step with respect to each phase space variable. We also describe enhancements that have enabled performance rates approaching 10 gigaflops on the full 128-node machine.

31383 (UCRL-JC–119758) **Optimizing tertiary storage organization and access for spatio-temporal datasets.** Chen, L.T. (Lawrence Berkeley Lab., CA (United States)); Rotem, D.; Shoshani, A.; Drach, B.; Keating, M.; Louis, S. Lawrence Livermore National Lab., CA (United States). Feb 1995. 20p. Sponsored by USDOE, Washington, DC (United States). DOE Contract W-7405-ENG-48. (CONF-9503106–3: Goddard conference on mass storage and technolgies, College Park, MD (United States), 28-30 Mar 1995). Order Number DE96000334. Source: OSTI; NTIS; GPO Dep.

We address in this paper data management techniques for efficiently retrieving requested subsets of large datasets stored on mass storage devices. This problem represents a major bottleneck that can negate the benefits of fast networks, because the time to access a subset from a large dataset stored on a mass storage system is much greater that the time to transmit that subset over a network. This paper focuses on very large spatial and temporal datasets generated by simulation programs in the area of climate modeling, but the techniques developed can be applied to other applications that deal with large multidimensional datasets. The main requirement we have addressed is the efficient access of subsets of information contained within much larger datasets, for the purpose of analysis and. interactive visualization. We have developed data partitioning techniques that partition datasets into "clusters" based on analysis of data access patterns and storage device characteristics. The goal is to minimize the number of clusters read from mass storage systems when subsets are requested. We emphasize in this paper proposed enhancements to current storage server protocols to permit control over physical placement of data on storage devices. We also discuss in some detail the aspects of the interface between the application programs and the mass storage system, as well as a workbench to help scientists to design the best reorganization of a dataset for anticipated access patterns.

31384 (UCRL-JC–119772-Rev.1) **The parallel I/O architecture of the high performance storage system (HPSS). Revision 1.** Watson, R.W. (Lawrence Livermore National Lab., CA (United States)); Coyne, R.A. Lawrence Livermore National Lab., CA (United States). Apr 1995. 20p. Sponsored by USDOE, Washington, DC (United States). DOE Contract W-7405-ENG-48. (CONF-950985–4-Rev.1: 14. Institute of Electrical and Electronics

Engineers (IEEE) symposium on mass storage systems, Monterey, CA (United States), 11-14 Sep 1995). Order Number DE95017813. Source: OSTI; NTIS; GPO Dep.

Datasets up to terabyte size and petabyte capacities have created a serious imbalance between I/O and storage system performance and system functionality. One promising approach is the use of parallel data transfer techniques for client access to storage, peripheral-to-peripheral transfers, and remote file transfers. This paper describes the parallel I/O architecture and mechanisms, Parallel Transport Protocol (PTP), parallel FTP, and parallel client Application Programming Interface (API) used by the High Performance Storage System (HPSS). Parallel storage integration issues with a local parallel file system are also discussed.

31385 (UCRL-JC–119787) **Nonlinear image filtering within IDP++.** Lehman, S.K.; Wieting, M.G.; Brase, J.M. Lawrence Livermore National Lab., CA (United States). 9 Feb 1995. 13p. Sponsored by USDOE, Washington, DC (United States). DOE Contract W-7405-ENG-48. (CONF-950226–57: SPIE '95: SPIE conference on optics, electro-optics, and laser application in science, engineering and medicine, San Jose, CA (United States), 5-14 Feb 1995). Order Number DE96000331. Source: OSTI; NTIS; GPO Dep.

IDP++, image and data processing in C++, is a set of a signal processing libraries written in C++. It is a multi-dimension (up to four dimensions), multi-data type (implemented through templates) signal processing extension to C++. IDP++ takes advantage of the object-oriented compiler technology to provide "information hiding." Users need only know C, not C++. Signals or data sets are treated like any other variable with a defined set of operators and functions. We here some examples of the nonlinear filter library within IDP++. Specifically, the results of MIN, MAX median, α-trimmed mean, and edge-trimmed mean filters as applied to a real aperture radar (RR) and synthetic aperture radar (SAR) data set.

31386 (UCRL-JC–121510) **Verifying the secure setup of Unix client/servers and detection of network intrusion.** Feingold, R.; Bruestle, H.R.; Bartoletti, T.; Saroyan, A.; Fisher, J. Lawrence Livermore National Lab., CA (United States). Jul 1995. 18p. Sponsored by Department of Defense, Washington, DC (United States). DOE Contract W-7405-ENG-48. (CONF-9510189–1: SPIE conference on photonic sensors and controls for commercial applications (Photonics East), Philadelphia, PA (United States), 22-26 Oct 1995). Order Number DE96000363. Source: OSTI; NTIS; GPO Dep.

This paper describes our technical approach to developing and delivering Unix host- and network-based security products to meet the increasing challenges in information security. Today's global "Infosphere" presents us with a networked environment that knows no geographical, national, or temporal boundaries, and no ownership, laws, or identity cards. This seamless aggregation of computers, networks, databases, applications, and the like store, transmit, and process information. This information is now recognized as an asset to governments, corporations, and individuals alike. This information must be protected from misuse. The Security Profile Inspector (SPI) performs static analyses of Unix-based clients and servers to check on their security configuration. SPI's broad range of security tests and flexible usage options support the needs of novice and expert system administrators alike. SPI's use within the Department of Energy and Department of Defense has resulted in more secure systems, less vulnerable to hostile intentions. Host-based information protection techniques and tools must also be supported by network-based capabilities. Our experience shows that a weak link in a network of clients and servers presents itself sooner or later, and can be more readily identified by dynamic intrusion detection techniques and tools. The Network Intrusion Detector (NID) is one such tool. NID is designed to monitor and analyze activity on an Ethernet broadcast Local Area Network segment and produce transcripts of suspicious user connections. NID's retrospective and real-time modes have proven invaluable to security officers faced with ongoing attacks to their systems and networks.

31387 (UCRL-JC–121616) **Programmable applications in a heterogeneous and concurrent environment.** Dubois, P.F. Lawrence Livermore National Lab., CA (United States). 21 Jul 1995. 16p. Sponsored by USDOE, Washington, DC (United States). DOE Contract W-7405-ENG-48. (CONF-9508167–1: Tools USA, Santa Barbara, CA (United States), 2 Aug 1995). Order Number DE95017868. Source: OSTI; NTIS; INIS; GPO Dep.

Equipe Basis (EB) is a new system for programmable applications which is under development at Lawrence Livermore Laboratory. EB is designed to permit user control of teams of interconnecting processes in a heterogeneous environment. Current systems work with programs written in Fortran or C on a single processor. The programs of the future will be in many languages and distributed over many processors. The object-oriented kernel can communicate data and commands between processes that are unaware of each other's inner structure. The programming language, Eiffel, is described. This document consists of extensive viewgraphs.

31388 (UCRL-JC–121635) **Application of optical interconnect technology at Lawrence Livermore National Laboratory.** Haigh, R.E.; Lowry, M.E.; McCammon, K.; Hills, R.; Mitchell, R.; Sweider, D. Lawrence Livermore National Lab., CA (United States). 10 Aug 1995. 5p. Sponsored by USDOE, Washington, DC (United States);Department of Defense, Washington, DC (United States). DOE Contract W-7405-ENG-48. (CONF-9511106–2: IEEE MILCOM 95: military communications, San Diego, CA (United States), 5-8 Nov 1995). Order Number DE96000384. Source: OSTI; NTIS; GPO Dep.

Optical interconnects will be required to meet the information bandwidth requirements of future communication and computing applications. At Lawrence Livermore National Laboratory, the authors are involved in applying optical interconnect technologies in two distinct application areas: Multi-Gigabit/sec Computer Backplanes and Gigabit/sec Wide Area Networking using Wavelength Division Multiplexing. In this paper, the authors discuss their efforts to integrate optical interconnect technologies into prototype computing and communication systems.

31389 (UCRL-JC–121813) **An efficient algorithm for geocentric to geodetic coordinate conversion.** Toms, R.M. Lawrence Livermore National Lab., CA (United States). Sep 1995. 10p. Sponsored by USDOE, Washington, DC (United States). DOE Contract W-7405-ENG-48. (CONF-9509159–1: 8. international conference on parallel and distributed computing systems, Orlando, FL (United States), 20-23 Sep 1995). Order Number DE95017706. Source: OSTI; NTIS; GPO Dep.

The problem of performing transformations from geocentric to geodetic coordinates has received an inordinate amount of attention in the literature. Numerous approximate methods have been published. Almost none of the publications address the issue of efficiency and in most cases there is a paucity of error analysis. Recently there has been a surge of interest in this problem aimed at developing more efficient methods for real time applications such as DIS. Iterative algorithms have been proposed that are not of optimal efficiency, address only one error component and require a small but uncertain number of relatively expensive iterations for convergence. In this paper a well known rapidly convergent iterative approach is modified to eliminate intervening trigonometric function evaluations. A total error metric is defined that accounts for both angular and altitude errors. The initial guess is optimized to minimize the error for one iteration. The resulting algorithm yields transformations correct to one centimeter for altitudes out to one million kilometers. Due to the rapid convergence only one iteration is used and no stopping test is needed. This algorithm is discussed in the context of machines that have FPUs and legacy machines that utilize mathematical subroutine packages.

31390 (UCRL-JC–121819) **Using the bootstrap in a multivariadte data problem: An example.** Glosup, J.G.; Axelrod, M.C. Lawrence Livermore National Lab., CA (United States). 1 Aug 1995. 7p. Sponsored by USDOE, Washington, DC (United States). DOE Contract W-7405-ENG-48. (CONF-9508165–3: Joint statistical meetings, Orlando, FL (United States), 13-17 Aug 1995). Order Number DE96001320. Source: OSTI; NTIS; INIS; GPO Dep.

The use of the bootstrap in the multivariate version of the paired t-test is considered and demonstrated through an example. The problem of interest involves comparing two different techniques for

measuring the chemical constituents of an sample item. The bootstrap is used to form an empirical significance level for Hotelling's one-sample T-squared statistic. The bootstrap was selected to determine empirical significance levels because the implicit assumption of multivariate normality in the classic Hotelling's one-sample test night not hold. The results of both the classic and bootstrap test are presented and contrasted.

31391 (UCRL-LR–121544) **Efficient biased random bit generation for parallel processing.** Slone, D.M. Lawrence Livermore National Lab., CA (United States). 28 Sep 1994. 99p. Sponsored by USDOE, Washington, DC (United States). DOE Contract W-7405-ENG-48. Order Number DE95017303. Source: OSTI; NTIS; GPO Dep.

A lattice gas automaton was implemented on a massively parallel machine (the BBN TC2000) and a vector supercomputer (the CRAY C90). The automaton models Burgers equation $\rho t + \rho\rho x = \nu\rho xx$ in 1 dimension. The lattice gas evolves by advecting and colliding pseudo-particles on a 1-dimensional, periodic grid. The specific rules for colliding particles are stochastic in nature and require the generation of many billions of random numbers to create the random bits necessary for the lattice gas. The goal of the thesis was to speed up the process of generating the random bits and thereby lessen the computational bottleneck of the automaton.

31392 (UCRL-MA–121327) **CombinePlt and CombineThs user manual: Merging multiple, processor-local plot and time-history data bases produced during a parallel calculation.** Procassini, R.J.; DeGroot, A.J. Lawrence Livermore National Lab., CA (United States). 1 Jun 1995. 21p. Sponsored by USDOE, Washington, DC (United States). DOE Contract W-7405-ENG-48. Order Number DE95017806. Source: OSTI; NTIS; GPO Dep.

The CombinePlt and CombineThs post-processing utilities are designed to merge the data in multiple, processor-local plot and time-history data bases produced by the parallel versions of the analysis codes DYNA3D, NIKE3D or PING into a serial data base which is compatible with the existing versions of the GRIZ and THUG visualization tools. These utilities make use of the partition assignment file produced by the PartMesh suite of pre-processing utilities to map the data from the processor-local order to global order. These utilities are also capable of translating 64-bit IEEE data bases into 32-bit IEEE data bases which are required for post-processing with GRIZ or THUG on an SGI workstation.

9903 Information Handling

Refer also to citation(s) 28688, 28781, 28798, 29094, 29141, 29647, 29648, 29816, 29840, 29858, 30568, 30640, 30853, 31038, 31039, 31042, 31053, 31054, 31055, 31056, 31057, 31058, 31059, 31060, 31061, 31094, 31290, 31291, 31292, 31293, 31294, 31327, 31356, 31357, 31358, 31359

31393 (CONF-941142–35) **Molecular dynamics on distributed-memory MIMD computers with load balancing.** Deng, Y. (State Univ. of New York, Stony Brook, NY (United States). Research Foundation); McCoy, R.A.; Marr, R.B.; Peierls, R.F.; Yasar, O. Oak Ridge National Lab., TN (United States); State Univ. of New York, Stony Brook, NY (United States). Research Foundation; Brookhaven National Lab., Upton, NY (United States). [1994]. 6p. Sponsored by USDOE, Washington, DC (United States). DOE Contract FG02-90ER25084 ; AC02-76CH00016 ; AC05-84OR21400. From American Society of Mechanical Engineers' winter annual meeting; Chicago, IL (United States); 6-11 Nov 1994. Order Number DE95014045. Source: OSTI; NTIS; GPO Dep.

We report two aspects of a computational molecular dynamics study of large-scale problems on a distributed-memory MIMD parallel computer: (1) efficiency and scalability results on Intel Paragon parallel computers with up to 512 nodes and (2) a new method for dynamic load balancing.

31394 (DOE/EIA–95017628) **1995-1996 Strategic Plan.** US-DOE Energy Information Administration, Washington, DC (United States). [1995]. 16p. Sponsored by USDOE, Washington, DC (United States). Order Number DE95017628. Source: OSTI; NTIS; GPO Dep.

In a rapidly changing world, effective governmental organizations must anticipate and plan for the future. Nowhere is this more true than in the realm of information generation and dissemination. The Energy Information Administration (EIA) faces a future of great opportunity and also significant challenge. Technological advances are providing opportunities to improve our work processes and the way we serve our customers. This year's Strategic Plan was developed by an EIA Strategic Planning Group with a membership that spans the entire organization. The Strategic Plan provides both a broad vision and a clear map of EIA's near-term future. The Strategic Planning Group conducted an analysis of the strengths and weaknesses of EIA as an organization, and of the opportunities and constraints facing EIA in the future. Opportunities exist in the future in technological advances and staff training; constraints lie in federal budget trends and staff demographics. This will require a Strategic Plan that recognizes the need to prioritize services and products across EIA, standardize technology across EIA where possible, lead with fewer layers of management, and be acutely aware of customer needs. Developing and training EIA employees to meet the challenges of rapidly changing technology and decreasing budgets were given high priority.

31395 (IAEA-NDS–0(rev.95/7)) **Index to the IAEA-NDS-Documentation Series.** IAEA-NDS–Documentation Series, IAEA-NDS–Documentation Series. Lemmel, H.D. International Atomic Energy Agency, Vienna (Austria). Nuclear Data Section. Jul 1995. 20p. Order Number DE96602790. Source: OSTI; NTIS (US Sales Only); INIS.

This index lists the current versions of the IAEA-NDS-documents which summarize contents and format of nuclear data libraries available from the IAEA Nuclear Data Section. (author).

31396 (IAEA-NDS–7(rev.95/7)) **Index of nuclear data libraries available from the IAEA Nuclear Data Section.** IAEA-NDS–Documentation Series, IAEA-NDS–Documentation Series. Lemmel, H.D. International Atomic Energy Agency, Vienna (Austria). Nuclear Data Section. Jul 1995. 49p. Order Number DE96602791. Source: OSTI; NTIS (US Sales Only); INIS.

This document lists more than 100 nuclear data libraries together with references that give more detailed information about these libraries. The data libraries include neutron cross-sections, resonance parameters, fission-product yields, nuclear structure and decay data, gamma-rays from radionuclides, data of nuclear reactions induced by charged particles or heavy ions, photonuclear data, photoatomic interaction data, and many others, partly related data processing computer codes. All data and documentation references are available upon request from the IAEA Nuclear Data Section, free of charge on magnetic tape, PC diskettes, or online through the INTERNET computer network: either menu driven within the Nuclear Data Information System (NDIS), or through FTP file transfer. (author).

31397 (IAEA-NDS–150(rev.95/6)) **Online nuclear data service.** IAEA-NDS–Documentation Series, IAEA-NDS–Documentation Series. Dunford, C.L. (International Atomic Energy Agency, Vienna (Austria). Nuclear Data Section); Burrows, T.W. International Atomic Energy Agency, Vienna (Austria). Nuclear Data Section. 1995. 92p. Order Number DE96602789. Source: OSTI; NTIS (US Sales Only); INIS.

The US National Nuclear Data Center and the IAEA Nuclear Data Section offer online computer access through international networks to their nuclear-physics and photoatomic numeric databases, related bibliographic systems and other related information of interest to basic and applied research and technology. A detailed description of the access procedures, the technical requirements, and the available databases is given. (author).

31398 (INIS-mf–14601) **7. Seminar of the IIE-ININ-IMP on technological specialties. Topic 10: Information Services.** Instituto de Investigaciones Electricas, Cuernavaca (Mexico); Instituto Nacional de Investigaciones Nucleares, Mexico City (Mexico); Instituto Mexicano de Petroleo, Mexico City (Mexico). 1994. 123p. (In Spanish). (CONF-9409366–: 7. seminar of the IIE-ININ-IMP on technological specialities, Distrito Federal (Mexico), 7 Sep 1994). Order Number DE96602792. Source: OSTI; NTIS (US Sales Only); INIS.

The document includes 10 papers presented at the 7. Seminar of the IIE-IMP-ININ (Mexico) on technological specialities in the field of information services (Topic 10). Three items were in INIS subject scope and a separate abstract was prepared for each of them.

31399 (KRC–92A-J07) **The Development of a Pulse Code Modulation(PCM) Bandwidth Compression System.** Park, S.Y. (Korea Electric Power Corp. (KEPCO), Taejon (Korea, Republic of). Research Center); Moon, H.K.; Choi, H.Y.; Kim, J.S.; Jo, S.J.; Jong, D.K.; Kim, H.S.; Kim, D.G.; Ko, B.J.; Woo, B.H.; Han, Y.M.; Chung, U.S.; Yoo, J.S.; Char, D.S.; Chung, J.W.; LKorea Electric Power Corp. (KEPCO), Taejon (Korea, Republic of). Research Center. 1993. 179p. (In Korean). Order Number DE96703562. Source: OSTI; NTIS (US Sales Only).

In this project, considering the transmission characteristics of the pair cables between branch offices, the optimum communication methodology and capacity were chosen the best line coding scheme without repeaters is investigated, and finally, an efficient and economic prototype of the target communication system which is applicable to an ISDN is designed and implemented. The developed system can operate with a capacity of either five channels of voice data at 24 kbps or six channels consisting of three voice channels at 24 kbps and three data channels at 9.6 kbps. For several months, a variety of field tests and modifications on the prototype were carried out. (author). 28 refs., figs.

31400 (KRC–93A-T05) **Development and Application of the MMI System Using Speech Synthesis.** Lee, K.J. (Korea Electric Power Corp. (KEPCO), Taejon (Korea, Republic of). Research Center); Cho, H.K.; Kim, S.K.; Kim, M.H.; Kook, J.Y.; Yoon, M.W.; Cho, W.S.; Lee, W.H.; Chung, S.J.; Chang, W.B.; Kim, D.W.; Seo, J.I.; Lee, S.W.; Kim, D.I.; Park, J.H.; LKorea Electric Power Corp. (KEPCO), Taejon (Korea, Republic of). Research Center. 1994. 156p. (In Korean). Order Number DE96703565. Source: OSTI; NTIS (US Sales Only).

As a speech synthesis technique, phoneme-saving method that is more useful than conventional PCM method is studied and implemented. This method is useful for compression of sound and is possible to the combination of phoneme. In our system, Alarm signals are presented by graphical diagram. And expert system is developed by constructing the knowledge base and inference control algorithm. This expert system diagnoses the causes of the abnormal states, and display the alarm signal on the screen and generates the speech signal by using the speech synthesis technology. In MMI system, the various user services using pull-down method are provided and, the states of each channel are represented by bar chart and characters using visual information. MMI system consists of 3 subsystems that are speech synthesis subsystem, expert system subsystem, and user interface subsystem. And this system can be separated by 6 modules that are expert system module, data-saving module, printing module, input data updating module, display module, and help module. (author). 23 refs., figs.

31401 (KRC–93N-07) **A Planning Study for Integrated Database System of Nuclear Power Plant.** Hong, S.R. (Korea Electric Power Corp. (KEPCO), Taejon (Korea, Republic of). Research Center); Kim, M.K.; Kang, D.H.; Ju, B.D.; Park, C.K.; Ham, J.J.; Kim, T.Y.; Kim, K.Y.; Ham, S.W.; Chung, W.D.; Sung, T.Y.; Choi, S.Y.; Park, J.H.; Park, Y.H. Korea Electric Power Corp. (KEPCO), Taejon (Korea, Republic of). Research Center. 1994. 474p. (In Korean). Order Number DE96703601. Source: OSTI; NTIS (US Sales Only).

It has been established a long-term research program during 1992-2000 to build an integrated database system of nuclear power plant. In order to conduct the program effectively, a planning study was performed. The objective of the study is to clarify the scope of the database, propose its blueprint, and establish a development plan. It has been conducted a survey of domestic and overseas status of database systems used in nuclear industries, and the requirements of various organizations has been surveyed. Based on the survey results, a configuration of the integrated database has been constructed, and the scope of the database, application programs and computing environment have been proposed. The integrated database system is consisted of Plant Specific Database and enterprise-wide Database. The Objective of the integrated Database is to acquire country-wide information and process it to extract overall plant performance statistics which is similar to INPO's NPRDS or NUPEC's NUSIRC. The Plant Specific Database is similar to PUMAS/N, but strengthens the scope of its application and quality and depth of data. To implement the blueprint, a master plan for the long term development program has been developed. The target plants cover 9 operating units and 11 constructing/scheduled units. (author). 457 refs.

31402 (LA-SUB–95-99) **LANL environmental restoration site ranking system: System description. Final report.** Merkhofer, L. (Applied Decision Analysis, Inc., Menlo Park, CA (United States)); Kann, A.; Voth, M. Los Alamos National Lab., NM (United States); Applied Decision Analysis, Inc., Menlo Park, CA (United States). 13 Oct 1992. 160p. Sponsored by USDOE, Washington, DC (United States). DOE Contract W-7405-ENG-36. (ADA–92-2106). Order Number DE95017359. Source: OSTI; NTIS; INIS; GPO Dep.

The basic structure of the LANL Environmental Restoration (ER) Site Ranking System and its use are described in this document. A related document, Instructions for Generating Inputs for the LANL ER Site Ranking System, contains detailed descriptions of the methods by which necessary inputs for the system will be generated. LANL has long recognized the need to provide a consistent basis for comparing the risks and other adverse consequences associated with the various waste problems at the Lab. The LANL ER Site Ranking System is being developed to help address this need. The specific purpose of the system is to help improve, defend, and explain prioritization decisions at the Potential Release Site (PRS) and Operable Unit (OU) level. The precise relationship of the Site Ranking System to the planning and overall budget processes is yet to be determined, as the system is still evolving. Generally speaking, the Site Ranking System will be used as a decision aid. That is, the system will be used to aid in the planning and budgetary decision-making process. It will never be used alone to make decisions. Like all models, the system can provide only a partial and approximate accounting of the factors important to budget and planning decisions. Decision makers at LANL will have to consider factors outside of the formal system when making final choices. Some of these other factors are regulatory requirements, DOE policy, and public concern. The main value of the site ranking system, therefore, is not the precise numbers it generates, but rather the general insights it provides.

31403 (LA-SUB–95-125) **Library Services Alliance of New Mexico. 1994 Annual report.** Los Alamos National Lab., NM (United States); Sumner Associates (United States). [1995]. 50p. Sponsored by USDOE, Washington, DC (United States). DOE Contract W-7405-ENG-36. Order Number DE95017812. Source: OSTI; NTIS; GPO Dep.

The Library Services Alliance is a unique multi-type library consortium committed to resource sharing. As a voluntary association of university and governmental laboratory libraries supporting scientific research, the Alliance has become a leader in New Mexico in using cooperative ventures to cost-effectively expand resources supporting their scientific and technical communities. During 1994, the alliance continued to expand on their strategic planning foundation to enhance access to research information for the scientific and technical communities. Significant progress was made in facilitating easy access to the on-line catalogs of member libraries via connections through the Internet. Access to Alliance resources is now available via the World Wide Web and Gopher, as well as links to other databases and electronic information. This report highlights the accomplishments of the Alliance during calendar year 1994.

31404 (LA-SUB–95-170) **Final report on the use of the modular-logic-nomenclature approach for the N-reactor probabilistic risk assessment.** Los Alamos National Lab., NM (United States); International Energy Associates Ltd., Albuquerque, NM (United States). 10 Jun 1986. 12p. Sponsored by USDOE, Washington, DC (United States). DOE Contract W-7405-ENG-36. Order Number DE96000854. Source: OSTI; NTIS; GPO Dep.

The N-Reactor probabilistic risk assessment adaption of the modular logic approach for fault tree modeling has led to the update of the master logic diagram (MLD) nomenclature to conform with a standard modular-logic-model-nomeclature format. This report describes the MLD nomenclature system and provides a listing of the updated MLD label codes, along with the original codes.

31405 (NEDO-IT–9308-Pt.1) **Investigation of inheritance of history of industrial technology. 1.** New Energy and Industrial Technology Development Organization, Tokyo (Japan). Mar 1994. 121p. (In Japanese). Order Number DE96704382. Source: OSTI; NTIS; Available from New Energy and Industrial Technology Development Organization, Sunshine 60, 30F 1-1, 3-chome, Higashi-Ikebukuro, Toshima-ku, Tokyo, Japan.

Basic investigation was conducted for the inheritance of industrial technology in the past and its creative utilization. The scope of investigation for fiscal 1992 was limited to cover some specific fields only, after considering what technology was creative and worth inheriting; that modern industrial technology is a highly specialized, complex system; and that it is near impossible to select creative and characteristic technology out of all the fields. As a result, the investigation was limited to cover only the car manufacturing of Toyota Motor Corporation, spinning of Toyoda Automatic Loom Works, Ltd., aerospace related activities of Mitsubishi Heavy Industries, Ltd., TV, electronic calculators, liquid crystal displays of Sharp Corporation, blast furnaces of Nippon Steel Corporation, turbines for ships of Kawasaki Heavy Industries Ltd., and the smeltering technology of Sumitomo Metal Industries, Ltd. The continuity of technology from pre-war days to post-war days and the different market conditions the businesses experienced after the war are reflected on the way each of the businesses had uniquely followed in the development of technology. A frank discussion of the efforts of engineers dealing with industry in a certain period and wrestling with the critical issues of society automatically built a way along which industrial technology will be inherited by the coming generation. A system is required whereunder historical data of industrial technology will be respected as public assets. 3 refs., 3 tabs.

31406 (NEDO-IT–9308-Pt.2) **Investigation of inheritance of history of industrial technology. 2.** New Energy and Industrial Technology Development Organization, Tokyo (Japan). Mar 1994. 107p. (In Japanese). Order Number DE96704383. Source: OSTI; NTIS; Available from New Energy and Industrial Technology Development Organization, Sunshine 60, 30F 1-1, 3-chome, Higashi-Ikebukuro, Toshima-ku, Tokyo, Japan.

For the inheritance of industrial technology in the past and to ensure its creative utilization, investigations were conducted into the current state of typical research information networks on the national and local level. In the process of development of industrial technology in Japan, local areas with their own peculiar traits assume very important roles. But, in such areas, important information about technology is being dissipated. As a typical network related to scientific and technological information, there exists the JOIS network of JICST, which enables the use of JICST-compiled literature and factual data base and other data bases JICST obtained from other organizations. In case of STN International of Germany, data base is a commonly owned property and each user can unlimitedly use the data bases belonging to other organizations. The Academic Information Center system offers information on books stored in university libraries and university-compiled data bases, and is equipped with the function of electronic mailing. In the Tsukuba Network the researchers living in Tsukuba Academic New Town are combined with each other by personal computer lines for performing information-related services. 41 figs., 10 tabs.

31407 (ORNL/TM–13055) **Groundwater, A century of word evolution.** Diefendorf, A.F. Oak Ridge National Lab., TN (United States). Aug 1995. 18p. Sponsored by USDOE, Washington, DC (United States). DOE Contract AC05-84OR21400. Order Number DE96000315. Source: OSTI; NTIS; INIS; GPO Dep.

Environmental Sciences Division Publication No. 4446.

Words, especially those that apply directly to more than one discipline, often become the object of intense debate among professionals in those disciplines. This is particularly true with those people who have to deal with technical jargon on a day-to-day basis and who are concerned that scientific facts get communicated in as clear and concise a manner as possible. Communications regarding environmental restoration projects for the US Department of Energy are no exception. Lockheed Martin Energy Systems, Inc., its subcontractors and other prime contractors often disagree about the spelling and use of compound words. This frequently results in inconsistent spelling between project reports and incorrect spelling of referenced document titles. The following discussion is an attempt to provide an objective, in-depth examination of the evolution of one particular word and recommendations for its proper and consistent use. This discussion is the result of an extensive literature search conducted within the library system at Oak Ridge National Laboratory as well as the personal geologic libraries of the author and colleagues. The author has attempted to cite only those works produced by recognized names in the related disciplines or those works that constitute common references or glossaries.

31408 (PNL-SA–26339) **Development of a network-based information infrastructure to facilitate hydrosystems and fisheries planning in the Columbia-Snake River Basin.** Johnson, G.E.; Scheibe, T.D. Pacific Northwest Lab., Richland, WA (United States). Jul 1995. 8p. Sponsored by USDOE, Washington, DC (United States). DOE Contract AC06-76RL01830 ; AI79-86BP62611. (CONF-9507158–1: 12. office information technology conference, Augusta, GA (United States), 17-20 Jul 1995). Order Number DE95016816. Source: OSTI; NTIS; GPO Dep.

This report describes the development of an information-exchange system on the World Wide Web to aid balancing Columbia-Snake River Basin hydropower operations and passage optimization for endangered anadromous salmonids. During the 1995 fish migration season, a working prototype of the service is being evaluated with input and guidance from the Federal fisheries agencies. Lessons learned will be used to enhance the service's value and implement suggested changes for full-scale implementation during 1996 and ensuing years. Illustrations of the system's World Wide Web pages, and documentation of the service's fundamental concepts and methods, are included in the report.

31409 (SAND–95-0666C-Rev.) **Proposed DSS-specific fields for the generic authentication information element.** Tarman, T.D. Sandia National Labs., Albuquerque, NM (United States). 6 Aug 1995. 5p. Sponsored by USDOE, Washington, DC (United States). DOE Contract AC04-94AL85000. (CONF-9508147–2-Rev.: ATM Forum Technical Committee meeting, Toronto (Canada), 6 Aug 1995). Order Number DE95016091. Source: OSTI; NTIS; GPO Dep.

This contribution proposes the format of the "Algorithm-Specific Information" and "Signature" fields within the "Proposed Generic Authentication Information Element" for authentication IEs based on the Digital Signature Standard (DSS). These fields are designed to allow various levels of authentication "strength" (or robustness), and many of these fields may be omitted in systems that optimize authentication performance by sharing common (public) Digital Signature Algorithm (DSA) parameters. This allows users and site security officers to design their authenticated signaling according to site security and performance requirements.

31410 (SAND–95-2147C-Draft) **Public/private key certification authority and key distribution. Draft.** Long, J.P.; Christensen, M.J.; Sturtevant, A.P.; Johnston, W.E. Sandia National Labs., Albuquerque, NM (United States). 25 Sep 1995. 25p. Sponsored by USDOE, Washington, DC (United States). DOE Contract AC04-94AL85000. (CONF-9509224–1-Draft: Joint meeting of Energy Science Coordinating Committee, Newport News, VA (United States), 28-29 Sep 1995). Order Number DE96000777. Source: OSTI; NTIS; GPO; GPO Dep.

Traditional encryption, which protects messages from prying eyes, has been used for many decades. The present concepts of encryption are built from that heritage. Utilization of modern software-based encryption techniques implies much more than simply converting files to an unreadable form. Ubiquitous use of computers and advances in encryption technology coupled with the use of wide-area networking completely changed the reasons for utilizing encryption technology. The technology demands a new and extensive infrastructure to support these functions. Full understanding of these functions, their utility and value, and the need for an infrastructure, takes extensive exposure to the new paradigm. This paper addresses issues surrounding the establishment and operation of a key management system (i.e., certification authority) that is essential to the successful implementation and wide-spread use of encryption.

31411 (UCRL-JC–20441) **Physical Volume Library deadlock avoidance in a striped media environment.** Deutsch, J.K. (IBM Government System, Houston, Texas (United States)); Gary, M.R. Lawrence Livermore National Lab., CA (United States). Mar 1995. 15p. Sponsored by USDOE, Washington, DC (United States). DOE Contract W-7405-ENG-48. (CONF-950985–5: 14. Institute of Electrical and Electronics Engineers (IEEE) symposium on mass storage systems, Monterey, CA (United States), 11-14 Sep 1995). Order Number DE96001315. Source: OSTI; NTIS; GPO Dep.

Most modern high performance storage systems store data in large repositories of removable media volumes. Management of the removable volumes is performed by a software module known as a Physical Volume Library (PVL). To meet performance and scalability requirements, a PVL may be asked to mount multiple removable media volumes for use by a single client for parallel data transfer. Mounting sets of volumes creates an environment in which it impossible for multiple client requests to deadlock while attempting to gain access to storage resources. Scenarios leading to deadlock in a PVL include multiple client requests that contend for the same cartridge(s), and client requests that vie for a limited set of drive resources. These deadlock scenarios are further complicated by the potential for out-of-order volumes to be mounted (for example, by Automatic Cartridge Loaders or human operators). This paper begins by introducing those PVL requirements Which create the possibility of deadlock. Next we examine traditional approaches to deadlock resolution and how they might be applied in a PVL. This leads to a design for a PVL which addresses deadlock scenarios. Following the design presentation is a discussion of possible design enhancements. We end with a case study of an actual implementation of the PVL design in the High Performance Storage System (HPSS).

31412 (WHC-SA–2931-FP) **Information/records management defensible budgets for the 21st century.** DiLiberto, A.J.; Whittet, L.A. Westinghouse Hanford Co., Richland, WA (United States). Aug 1995. 15p. Sponsored by USDOE, Washington, DC (United States). DOE Contract AC06-87RL10930. (CONF-950876–2: 19. annual symposium of the Nuclear Information Records Management Association, Washington, DC (United States), 27-30 Aug 1995). Order Number DE96001103. Source: OSTI; NTIS; GPO Dep.

This paper provides to the Nuclear Information and Records Management Association (NIRMA) members the skills, knowledge, and information needed to develop performance-based cost estimating. It includes a detailed basis of estimates to represent a work breakdown structure that is technically complete, fully documented, defensible to various external reviews, and validatable.

Corporate Author Index

This index lists the corporate authors responsible for issuing the documents in this publication which are identified primarily by report number. The corporate names are entered in standardized forms as defined in ETDE/PUB–3 (Rev.1), *International Energy: Research Organizations 1988–1992*. Each entry under a corporate name includes the document title and citation number. Three items of information may appear in parentheses: (1) an abbreviation to identify the document type, such as a report; (2) the country of publication, indicated by International Organization for Standardization (ISO) country code; and (3) the language of the document if non-English (R;CA;In French). Author affiliations are not listed in this index.

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AC04-94AL85000	**Aerojet-General Corp., Sacramento, CA (United States)**	
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AC05-76OR00001	**Lockheed Martin Utility Services, Inc., Oak Ridge, TN (United States)**	
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AC05-76OR00033	**Oak Ridge Inst. for Science and Education, TN (United States)**	
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AC05-84ER40150	**Southeastern Universities Research Association, Inc., Newport News, VA (United States)**	
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	Southeastern Universities Research Association, Inc., Newport News, VA (United States). Continuous Electron Beam Accelerator Facility	
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AC06-76RL01830	**Douglas United Nuclear, Inc., Richland, WA (United States)**	
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	Fermi National Accelerator Lab., Batavia, IL (United States)	
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	20:28839	INEL-95/0161
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	20:28843	INEL-95/0225
	20:28849	INEL-95/0414
	20:29378	DOE/ID-10430(CT)
	Idaho National Engineering Lab., Idaho Falls, ID (United States)	
	20:28828	INEL-94/0095
	20:28834	INEL-95/0036
	20:28837	INEL-95/0129
	20:30288	INEL-95/00079
	20:30884	INEL-95/00106
	20:31336	INEL-94/00081
	EG and G Idaho, Inc., Idaho Falls, ID (United States)	
	20:28845	INEL-95/0273
	20:29093	INEL-95/0274
	20:29094	INEL-95/0422
	20:29380	DOE/ID-10430(ME)
	20:29972	INEL-95/0309
	20:30710	INEL-95/0101
	20:31330	ESTSC-001001SPARC00
	Lockheed Idaho Technologies Co., Idaho Falls, ID (United States)	
	20:28777	DOE/LLW-192
	20:28779	INEL-95/0167
	20:28810	DOE/LLW-128
	20:28811	DOE/LLW-129-Vol.13
	20:28813	DOE/LLW-187
	20:28817	DOE/LLW-221
	20:28829	INEL-94/0119
	20:28831	INEL-95/0013
	20:28832	INEL-95/0014-Rev.1
	20:28833	INEL-95/0016-Rev.1
	20:28836	INEL-95/0114
	20:28838	INEL-95/00137
	20:28841	INEL-95/0194
	20:28844	INEL-95/0272
	20:28846	INEL-95/0302
	20:28847	INEL-95/00320
	20:28848	INEL-95/0321
	20:28850	INEL-95/0442
	20:29091	INEL-95/00080

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	20:29092	INEL–95/0182
	20:29379	DOE/ID–10430(MA)
	20:29381	DOE/ID–10430(RI)
	20:29383	DOE/ID–10510(94-95)
	20:29523	INEL–95/00174
	20:29581	INEL–95/00381
	20:30287	INEL–94/00106
	20:30657	INEL–95/00444
	20:30711	INEL–95/0132(94)
	20:30823	INEL–95/0185
AC08-88NV10617	**EG and G Energy Measurements, Inc., Las Vegas, NV (United States)**	
	20:30703	EGG–10617-1238
	EG and G Energy Measurements, Inc., Las Vegas, NV (United States). Remote Sensing Lab.	
	20:29452	EGG–10617-1230
AC08-93NV11265	**EG and G Energy Measurements, Inc., Los Alamos, NM (United States). Los Alamos Operations**	
	20:30507	EGG–11265-5019
	20:30846	EGG–11265-5032
	20:31318	EGG–11265-5031
	Los Alamos National Lab., NM (United States)	
	20:30295	LA-UR–95-2322
	20:30456	LA-UR–95-3102
	20:30546	LA-UR–95-2407
	EG and G Energy Measurements, Inc., Las Vegas, NV (United States)	
	20:29086	EGG–11265-1122
	20:30632	EGG–11265-1118
	20:30633	EGG–11265-1125
	20:30704	EGG–11265-1087
	20:30843	EGG–11265-1124
	20:31317	EGG–11265-1130
	EG and G Energy Measurements, Inc., Goleta, CA (United States). Santa Barbara Operations	
	20:30107	EGG–11265-1120
	EG and G Energy Measurements, Inc., Las Vegas, NV (United States). Las Vegas Area Operations	
	20:30707	EGG–11265-2047
	EG and G Energy Measurements, Inc., Tupman, CA (United States)	
	20:30705	EGG–11265-1134
	20:30785	EGG–11265-1135
	EG and G Energy Measurements, Inc., Las Vegas, NV (United States). Environmental Sciences Div.	
	20:28718	EGG–11265-1115
	20:30706	EGG–11265-2019
AC08-94NV11432	**Reynolds Electrical and Engineering Co., Inc., Las Vegas, NV (United States)**	
	20:30642	DOE/NV/11432–197
	20:30701	DOE/NV–11432-195
AC08-95NV11508	**Nevada Univ., Las Vegas, NV (United States). Water Resources Center**	
	20:30702	DOE/NV/11508–01
AC09-89SR18035	**Westinghouse Savannah River Co., Aiken, SC (United States)**	
	20:28997	WSRC-MS–94-0640
	20:28998	WSRC-MS–95-0184
	20:28999	WSRC-MS–95-0192
	20:29000	WSRC-MS–95-0353
	20:29001	WSRC-TR–94-0618
	20:29002	WSRC-TR–95-0059
	20:29003	WSRC-TR–95-0071
	20:29004	WSRC-TR–95-0085
	20:29005	WSRC-TR–95-0230
	20:29006	WSRC-TR–95-0502
	20:29087	ESH-EMS–940516
	20:29121	WSRC-TR–95-0012
	20:29122	WSRC-TR–95-0138-1-Vol.1
	20:29123	WSRC-TR–95-0138-1-Vol.2
	20:29124	WSRC-TR–95-0138-1-Vol.3
	20:29858	WSRC-MS–95-0300
	20:30228	WSRC-MS–95-0376
	20:30286	EFR-TDD–950060
	20:30308	PATENTS-US–A8075900
	20:30330	WSRC-MS–95-0386
	20:30348	WSRC-MS–95-0384
	20:30356	WSRC-TR–95-0016
	20:30684	WSRC-RP–93-1322
	20:30765	WSRC-RP–95-89
	20:30766	WSRC-TR–94-0609
	20:30767	WSRC-TR–95-0050
	20:30768	WSRC-TR–95-0145-2
	20:30769	WSRC-TR–95-0276
	20:30770	WSRC-TR–0137-2
	20:30782	WSRC-RP–95-722
AC21-87MC24257	**Westinghouse Electric Corp., Pittsburgh, PA (United States). Science and Technology Center**	
	20:28592	DOE/MC/24257–5003
AC21-93MC30086	**Alabama Univ., University, AL (United States)**	
	20:28732	CONF-950572–
	20:28733	CONF-950572–
AC21-93MC30246	**Solar Turbines International, San Diego, CA (United States)**	
	20:29429	DOE/MC/30246–4066
AC21-94MC30088	**Maurer Engineering, Inc., Houston, TX (United States)**	
	20:28740	DOE/MC/30088–95/C0474
AC21-94MC31114	**ICF Resources, Inc., Fairfax, VA (United States)**	
	20:28754	DOE/MC/31114–95/C0487
AC21-94MC31197	**Maurer Engineering, Inc., Houston, TX (United States)**	
	20:28701	DOE/MC/31197–95/C0472
AC21-94MC31224	**Coleman Research Corp., Golden, CO (United States)**	
	20:28735	DOE/MC/31224–5021
AC22-86PC91257	**TRW, Inc., Redondo Beach, CA (United States)**	
	20:28608	DOE/PC/91257–T21
	20:28609	DOE/PC/91257–T23
	TRW, Inc., Redondo Beach, CA (United States). Applied Technology Div.	
	20:28610	DOE/PC/91257–T24
	20:28611	DOE/PC/91257–T26
AC22-88PC88819	**Amoco Oil Co., Naperville, IL (United States). Research and Development Dept.**	
	20:28596	DOE/PC/88819–T18
	20:28597	DOE/PC/88819–T19
AC22-91PC90048	**Universal Fuel Development Associates, Inc., Grand Forks, ND (United States)**	
	20:28598	DOE/PC/90048–T4
	20:28599	DOE/PC/90048–T5
	20:28600	DOE/PC/90048–T6
	20:28601	DOE/PC/90048–T7
	20:28602	DOE/PC/90048–T8
	20:28603	DOE/PC/90048–T9
	20:28604	DOE/PC/90048–T10
AC22-91PC90180	**Pittsburgh Univ., PA (United States). Dept. of Mechanical Engineering**	
	20:28661	DOE/PC/90180–T14

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AC22-91PC90183	**Cornell Univ., Ithaca, NY (United States)**	
	20:30334	DOE/PC/90183–T16
AC22-91PC91056	**Chicago Univ., IL (United States). Dept. of Chemistry**	
	20:28606	DOE/PC/91056–T9
	20:28607	DOE/PC/91056–T10
AC22-91PC91154	**Foster Wheeler Development Corp., Livingston, NJ (United States)**	
	20:29430	DOE/PC/91154–T9
AC22-91PC91160	**ABB Combustion Engineering, Inc., Windsor, CT (United States)**	
	20:28669	DOE/PC/91160–T6
	ABB Combustion Engineering Systems, Windsor, CT (United States). U.S. Power Plant Labs.	
	20:28670	DOE/PC/91160–T7
AC22-91PC91337	**NOXSO Corp., Library, PA (United States)**	
	20:28651	DOE/PC/91337–T3
	20:28652	DOE/PC/91337–T4
	20:28653	DOE/PC/91337–T5
	20:28654	DOE/PC/91337–T6
AC22-92BC14831	**Louisiana State Univ., Baton Rouge, LA (United States). Dept. of Petroleum Engineering**	
	20:28677	DOE/BC/14831–14-Rev.1
AC22-92BC14880	**New Mexico Highlands Univ., Las Vegas, NM (United States). Dept. of Chemistry**	
	20:28689	DOE/BC/14880–14
AC22-92BC14884	**Columbia Univ., New York, NY (United States)**	
	20:28690	DOE/BC/14884–14
AC22-92BC14886	**Surtek, Inc., Golden, CO (United States)**	
	20:28691	DOE/BC/14886–13
AC22-92MT92002	**Tulane Univ., New Orleans, LA (United States). Dept. of Chemical Engineering**	
	20:28717	DOE/MT/92002–11
AC22-92MT92009	**Resource Technology Corp., Laramie, WY (United States)**	
	20:28715	DOE/MT/92009–T2
AC22-92PC91155	**United Technologies Research Center, East Hartford, CT (United States)**	
	20:29431	DOE/PC/91155–T11
AC22-92PC91338	**Radian Corp., Austin, TX (United States)**	
	20:29444	DOE/PC/91338–T9
AC22-92PC92106	**Surface/Interface, Inc., Mountain View, CA (United States)**	
	20:30231	DOE/PC/92106–T10
AC22-92PC92108	**Energy International Corp., Pittsburgh, PA (United States)**	
	20:28616	DOE/PC/92108–T10
AC22-92PC92110	**Colorado School of Mines, Golden, CO (United States)**	
	20:28741	DOE/PC/92110–T9
AC22-92PC92112	**SRI International, Menlo Park, CA (United States)**	
	20:28742	DOE/PC/92112–T10
AC22-92PC92122	**Pennsylvania State Univ., University Park, PA (United States). Dept. of Materials Science and Engineering**	
	20:28617	DOE/PC/92122–T10
AC22-92PC92205	**Virginia Center for Coal and Minerals Processing, Blacksburg, VA (United States)**	
	20:28583	DOE/PC/92205–T7
AC22-92PC92208	**AMAX Research and Development Center, Golden, CO (United States)**	
	20:28584	DOE/PC/92208–T10
AC22-93BC14896	**Utah Geological and Mineral Survey, Salt Lake City, UT (United States)**	
	20:28678	DOE/BC/14896–8
AC22-93PC92147	**Hydrocarbon Technologies, Inc., Lawrenceville, NJ (United States)**	
	20:28618	DOE/PC/92147–10
AC22-93PC92190	**USDOE Pittsburgh Energy Technology Center, PA (United States)**	
	20:28672	DOE/PC/92190–T8
AC22-94PC91008	**BDM Oklahoma, Inc., Bartlesville, OK (United States)**	
	20:28703	NIPER/BDM–0074
AC22-94PC93054	**CONSOL, Inc., Library, PA (United States)**	
	20:28641	DOE/PC/93054–14
	CONSOL, Inc., Library, PA (United States). Research and Development Dept.	
	20:28590	CONF-950402–12
	20:28591	CONF-950402–13
AC22-94PC93066	**Kentucky Univ., Lexington, KY (United States)**	
	20:28619	DOE/PC/93066–T1
	20:28620	DOE/PC/93066–T2
	20:28621	DOE/PC/93066–T3
	20:28622	DOE/PC/93066–T4
	20:28623	DOE/PC/93066–T5
AC22-94PC94055	**Kentucky Univ., Lexington, KY (United States). Research Foundation**	
	20:28624	DOE/PC/94055–T2
AC22-94PC94065	**Research Triangle Inst., Research Triangle Park, NC (United States)**	
	20:28625	DOE/PC/94065–T2
AC24-88DP43495	**Mound Lab., Miamisburg, OH (United States)**	
	20:28901	MLM–277
	20:29163	MLM–204
	20:29164	MLM–220
	20:29166	MLM–251
	20:29178	MLM–200
	20:29179	MLM–242
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	EG and G Mound Applied Technologies, Miamisburg, OH (United States)	
	20:29099	MLM-MU–89-62-0007
	20:29100	MLM-MU–89-63-0006
	20:29132	MLM–3676
	20:29133	MLM-MU–89-63-0002
	20:29787	MLM-MU–89-62-0004
	20:30303	MLM-MU–89-62-0003
	20:30305	MLM-MU–89-64-0013
	20:30739	MLM-MU–89-63-0001
	20:30740	MLM-MU–89-64-0012
	Monsanto Chemical Co., Dayton, OH (United States)	
	20:29156	MLM–23
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	Mound, Miamisburg, OH (United States)	
	20:28902	MLM–2240(LD)
	20:29165	MLM–236
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	20:30304	MLM-MU–89-64-0008
	20:30563	MLM–108

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AC24-92OR21972	**Fernald Environmental Restoration Management Corp., Cincinnati, OH (United States). Fernald Environmental Management Project**	
	20:29025	FEMP/SUB–102
	20:29088	FEMP–2362B
	20:29089	FEMP/SUB–095
	20:29090	FEMP/SUB–096
AC35-89ER40486	**Lawrence Berkeley Lab., CA (United States). SSC Central Design Group**	
	20:30415	SSC-SR–1026
	20:30416	SSC-SR–1031
	20:30483	SSC-SR–1018
	20:30484	SSC-SR–1023
	20:30485	SSC-SR–1028
	20:30486	SSC-SR–1036
	20:30524	SSC-SR–1039
	Superconducting Super Collider Lab., Dallas, TX (United States)	
	20:30414	SSCL-SR–1222
	20:30439	SSCL–282
	20:30440	SSCL-Preprint–223
	20:30441	SSCL-Preprint–510
	20:30480	SSCL–673
	20:30481	SSCL-Preprint–509-Rev.1
	20:30482	SSCL-SR–1029
AC36-83CH10093	**National Renewable Energy Lab., Golden, CO (United States)**	
	20:29394	NREL/TP–411-8122
	20:29395	NREL/TP–442-8108
	20:29424	NREL/TP–442-6912
	20:29425	NREL/TP–442-7391
	20:29867	DOE/GO–10095-197
	20:29903	DOE/GO–10094-040
	20:29904	DOE/GO–10095-194
	20:29978	NREL/TP–425-6969
	20:29979	NREL/TP–425-7619
	20:30842	DOE/GO–10095-014
AD07-93ID10513	**USDOE Office of Environmental Restoration and Waste Management, Washington, DC (United States). Office of Technology Development**	
	20:29073	DOE/ID–10513
AI01-84ER52113	**National Inst. of Standards and Technology (NEL), Boulder, CO (United States). Electromagnetic Technology Div.**	
	20:31230	NISTIR–5013
AI02-93ER25188	**National Inst. of Standards and Technology, Gaithersburg, MD (United States)**	
	20:31315	DOE/ER/25188–T1
AI08-78ET44802	**Lawrence Berkeley Lab., CA (United States)**	
	20:30850	LBL–37356
AI08-86NV10583	**Geological Survey, Denver, CO (United States)**	
	20:30761	USGS-OFR–95-160
	20:30762	USGS-OFR–95-284
AI08-92NV10874	**Geological Survey, Denver, CO (United States)**	
	20:29010	CONF-940553–86
	20:29011	CONF-940553–90
	20:29012	CONF-940553–93
	20:30689	CONF-940553–87
	20:30690	CONF-940553–88
	20:30691	CONF-940553–91
	20:30692	CONF-940553–95
	20:30693	CONF-940553–96
	Geological Survey, Mercury, NV (United States)	
	20:30688	CONF-940553–85
AI79-86BP62611	**Pacific Northwest Lab., Richland, WA (United States)**	
	20:31408	PNL-SA–26339
AR21-93MC30361	**Aerojet-General Corp., Sacramento, CA (United States)**	
	20:28818	DOE/MC/30361–95/C0498
	20:28819	DOE/MC/30361–4087
AS03-76ER70285	**Stanford Linear Accelerator Center, Menlo Park, CA (United States)**	
	20:30413	SLAC-PUB–95-6757
FC03-92SF19460	**Rochester Univ., NY (United States). Lab. for Laser Energetics**	
	20:31211	DOE/SF–19460-91
FC21-87MC24132	**American Electric Power Service Corp., Columbus, OH (United States)**	
	20:28662	DOE/MC/24132–5002
FC21-89MC26042	**American Electric Power Service Corp., Columbus, OH (United States)**	
	20:29447	DOE/MC/26042–4083
FC21-90MC25140	**Southern Co. Services, Inc., Birmingham, AL (United States)**	
	20:28593	DOE/MC/25140–5005
FC21-90MC27229	**Thermochem, Inc., Columbia, MD (United States)**	
	20:28664	DOE/MC/27229–5007
FC21-91MC27205	**Doniee Technologies, Inc., York, PA (United States)**	
	20:28663	DOE/MC/27205–5006
FC21-91MC27362	**Bethlehem Steel Corp., PA (United States)**	
	20:28577	DOE/MC/27362–4089
FC21-91MC27363	**Tampa Electric Co., FL (United States)**	
	20:29428	DOE/MC/27363–5012
FC21-91MC28055	**Westinghouse Electric Corp., Pittsburgh, PA (United States). Science and Technology Center**	
	20:29887	DOE/MC/28055–95/C0493
FC22-90PC89651	**Southern Co. Services, Inc., Birmingham, AL (United States)**	
	20:28668	DOE/PC/89651–T22
FC22-90PC89652	**Southern Co. Services, Inc., Birmingham, AL (United States)**	
	20:28648	DOE/PC/89652–T11
FC22-90PC89664	**Western Energy Co., Colstrip, MT (United States)**	
	20:28581	DOE/PC/89664–T12
	Power Environmental Services, Inc., Butte, MT (United States)	
	20:28580	DOE/PC/89664–T11
FC22-91PC90542	**Tennessee Valley Authority, Chattanooga, TN (United States)**	
	20:29442	DOE/PC/90542–T10
FC22-91PC90547	**Energy and Environmental Research Corp., Irvine, CA (United States)**	
	20:28649	DOE/PC/90547–T19
	20:29443	DOE/PC/90547–T20
FC22-93BC14953	**Utah Dept. of Natural Resources, Salt Lake City, UT (United States)**	
	20:28680	DOE/BC/14953–11
FC22-93BC14954	**Diversified Operating Corp., Denver, CO (United States)**	
	20:28693	DOE/BC/14954–12
FC22-93BC14956	**Oklahoma Univ., Norman, OK (United States)**	
	20:28694	DOE/BC/14956–10
	20:28695	DOE/BC/14956–11

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FC22-93BC14957	Kansas Univ., Lawrence, KS (United States)	
	20:28696	DOE/BC/14957–7
FC22-93BC14960	Texaco Exploration and Production, Inc., New Orleans, LA (United States)	
	20:28697	DOE/BC/14960–11
FC22-94BC14984	Syndetix, Inc., Las Cruces, NM (United States)	
	20:28682	DOE/BC/14984–5
FC22-94BC14989	Fina Oil and Chemical Co., Midland, TX (United States)	
	20:28683	DOE/BC/14989–6
FC22-94BC14990	Oxy USA, Inc., Midland, TX (United States)	
	20:28699	DOE/BC/14990–4
FC22-95BC14934	Long Beach City Dept. of Oil Properties, CA (United States)	
	20:28679	DOE/BC/14934–1
FG01-91CE15492	X-Form, Inc., Troy, NY (United States)	
	20:29998	DOE/CE/15492–T6
FG01-92CE15544	South Dakota State Univ., Brookings, SD (United States)	
	20:30697	DOE/CE/15544–T12
FG01-92EW50625	Medical Univ. of South Carolina, Charleston, SC (United States)	
	20:30631	DOE/EW/50625–T25
FG01-93EP10050	East-West Center, Honolulu, HI (United States)	
	20:28748	DOE/EP/10050–T8
FG01-94CE15554	Mississippi Forest Products Utilization Lab., Mississippi State, MS (United States)	
	20:29925	DOE/CE/15554–T5
FG01-94CE15594	Bio-Process Innovation, Inc., West Lafayette, IN (United States)	
	20:29244	DOE/CE/15594–T5
	20:29245	DOE/CE/15594–T7
	Environmental Science and Research Foundation, Idaho Falls, ID (United States)	
	20:29246	DOE/CE/15594–T8
FG01-95EE15623	EnerTech Environmental, Inc., Atlanta, GA (United States)	
	20:29249	DOE/EE/15623–T2
FG02-85ER45215	Wisconsin Univ., Madison, WI (United States)	
	20:29994	CONF-910872–10
FG02-86ER13491	Kansas State Univ., Manhattan, KS (United States). J.R. MacDonald Lab.	
	20:31101	DOE/ER–13491-798
FG02-86ER13500	Wisconsin Univ., Madison, WI (United States)	
	20:31112	DOE/ER/13500–T4
FG02-86ER40281	Lawrence Berkeley Lab., CA (United States)	
	20:31088	UCRL-ID–121571
FG02-89ER12901	Oregon State Univ., Corvallis, OR (United States). Dept. of Nuclear Engineering	
	20:29487	DOE/ER/12901–T1
FG02-89ER52161	Rensselaer Polytechnic Inst., Troy, NY (United States)	
	20:30024	DOE/ER/52161–T2
FG02-90ER25084	Oak Ridge National Lab., TN (United States)	
	20:31393	CONF-941142–35
	Los Alamos National Lab., NM (United States)	
	20:30722	LA-UR–95-2707
FG02-90ER61029	Clarkson Univ., Potsdam, NY (United States). Dept. of Chemical Engineering	
	20:30562	DOE/ER/61029–19
FG02-91CE23810	National Inst. of Standards and Technology, Gaithersburg, MD (United States). Building and Fire Research Lab.	
	20:29902	DOE/CE/23810–58
	Spauschus Associates, Inc., Stockbridge, GA (United States)	
	20:29926	DOE/CE/23810–54
	Air-Conditioning and Refrigeration Inst., Arlington, VA (United States)	
	20:30349	DOE/CE/23810–50
FG02-91ER14192	National Renewable Energy Lab., Golden, CO (United States)	
	20:30262	NREL/CP–433-7748
FG02-91ER40672	Stanford Linear Accelerator Center, Menlo Park, CA (United States)	
	20:30905	SLAC-PUB–95-6915
	20:31016	SLAC-PUB–95-7004
	Stanford Univ., CA (United States)	
	20:31015	SLAC-PUB–95-6933
FG02-91ER40676	Stanford Linear Accelerator Center, Menlo Park, CA (United States)	
	20:31016	SLAC-PUB–95-7004
	Stanford Univ., CA (United States)	
	20:31015	SLAC-PUB–95-6933
FG02-91ER40677	Stanford Linear Accelerator Center, Menlo Park, CA (United States)	
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	Stanford Univ., CA (United States)	
	20:31015	SLAC-PUB–95-6933
FG02-92ER54169	Lodestar Research Corp., Boulder, CO (United States)	
	20:31158	DOE/ER/54169–T1
FG02-92ER61360	Denver Univ., CO (United States). Dept. of Physics	
	20:30641	DOE/ER/61360–2
FG02-92ER75701	Rensselaer Polytechnic Inst., Troy, NY (United States). Center for Multiphase Research	
	20:29451	DOE/ER/75701–2
FG02-92ER75706	Arizona Univ., Tucson, AZ (United States). Engineering Experiment Station	
	20:29522	DOE/ER/75886–T2
FG02-92ER75707	New Mexico Univ., Albuquerque, NM (United States). Dept. of Chemical and Nuclear Engineering	
	20:31134	DOE/ER/75707–T1
FG02-92ER75755	New York Zoological Society, NY (United States)	
	20:29387	DOE/ER/75755–T1
FG02-93ER61674	Institute for Genomic Research, Gaithersburg, MD (United States)	
	20:30798	DOE/ER/61674–1
FG02-94CE50388	Society of Automotive Engineers, Inc., Warrendale, PA (United States)	
	20:29973	CONF-9406355–Absts.
FG02-94ER14444	Kansas State Univ., Manhattan, KS (United States). Dept. of Physics	
	20:30283	DOE/ER/14444–1
FG02-94ER25197	Society for Industrial and Applied Mathematics, Philadelphia, PA (United States)	
	20:31313	CONF-9406184–Final
FG02-94ER45522	Brandeis Univ., Waltham, MA (United States)	
	20:30162	DOE/ER/45522–3
	Brandeis Univ., Waltham, MA (United States). Dept. of Physics	
	20:31116	DOE/ER/45522–2
FG03-89ER13987	Monsanto Research Corp., Miamisburg, OH (United States). Mound	
	20:30102	DOE/ER/13987–T1

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FG03-91ER40618	Stanford Linear Accelerator Center, Menlo Park, CA (United States)	
	20:31016	SLAC-PUB–95-7004
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FG03-92ER40689	Stanford Linear Accelerator Center, Menlo Park, CA (United States)	
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FG03-92ER40701	Stanford Linear Accelerator Center, Menlo Park, CA (United States)	
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FG03-92ER81285	Lawrence Livermore National Lab., CA (United States)	
	20:30487	UCRL-JC–119358
FG03-93ER40757	Texas Univ., Austin, TX (United States). Dept. of Physics	
	20:30920	DOE/ER/40757–003
FG03-93ER40788	Stanford Linear Accelerator Center, Menlo Park, CA (United States)	
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FG03-93ER75881	New Mexico Univ., Albuquerque, NM (United States). Dept. of Chemical and Nuclear Engineering	
	20:31134	DOE/ER/75707–T1
FG03-93ER75886	Arizona Univ., Tucson, AZ (United States). Engineering Experiment Station	
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FG03-93ER81502	Alabama Univ., University, AL (United States)	
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	20:28737	CONF-950572–
FG03-94ER40853	Houston Univ., TX (United States)	
	20:30398	DOE/ER/40853–4
FG03-94ER75955	Fort Worth Museum of Science and History, TX (United States). Interpretive Div.	
	20:31299	DOE/ER/75955–T2
FG04-94AL98816	New Mexico State Univ., Las Cruces, NM (United States)	
	20:29849	DOE/AL/98816–T2
FG05-80ET53088	Texas Univ., Austin, TX (United States). Inst. for Fusion Studies	
	20:31133	DOE/ET/53088–716
	20:31159	DOE/ET/53088–717
FG06-89ER14047	Oregon State Univ., Corvallis, OR (United States). Dept. of Microbiology	
	20:30788	DOE/ER/14047–18
FG06-90ER40537	Washington Univ., Seattle, WA (United States). Nuclear Physics Lab.	
	20:30284	DOE/ER/40537–50
	20:30445	DOE/ER/40537–51
FG06-91ER14171	Oregon State Univ., Corvallis, OR (United States). Dept. of Mechanical Engineering	
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FG06-93ER79198	South Dakota School of Mines and Technology, Rapid City, SD (United States)	
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FG06-94ER76005	Washington Univ., Seattle, WA (United States)	
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FG07-90ID13040	Oregon Inst. of Tech., Klamath Falls, OR (United States). Geo-Heat Center	
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FG08-94NV11630	Michigan Univ., Ann Arbor, MI (United States). Dept. of Nuclear Engineering	
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FG09-84ER40160	Georgia Univ., Athens, GA (United States). Dept. of Physics and Astronomy	
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FG09-84ER60255	South Carolina Univ., Columbia, SC (United States). Dept. of Biological Sciences	
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	20:30838	DOE/ER/60255–T2
FG09-94SR18445	North Carolina Agricultural and Technical State Univ., Greensboro, NC (United States)	
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FG22-89PC89766	California Univ., Berkeley, CA (United States). Dept. of Materials Science and Mineral Engineering	
	20:28582	DOE/PC/89766–T18
FG22-89PC89773	Massachusetts Inst. of Tech., Cambridge, MA (United States)	
	20:28637	DOE/PC/89773–T4
FG22-90PC90291	Delaware Univ., Newark, DE (United States)	
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FG22-91PC91293	Massachusetts Inst. of Tech., Cambridge, MA (United States). Dept. of Chemical Engineering	
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FG22-91PC91300	North Carolina Agricultural and Technical State Univ., Greensboro, NC (United States). Dept. of Chemical Engineering	
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FG22-91PC91306	Tennessee Univ., Knoxville, TN (United States). Dept. of Chemistry	
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FG22-91PC91307	Rice Univ., Houston, TX (United States). Dept. of Chemical Engineering	
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FG22-92MT92017	Clark Atlanta Univ., GA (United States)	
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FG22-92MT92018	Hampton Univ., VA (United States). Dept. of Engineering	
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FG22-92MT92019	Grambling State Univ., LA (United States). Dept. of Chemistry	
	20:28578	DOE/MT/92019–T3
	20:28579	DOE/MT/92019–T4
FG22-92PC92152	Carnegie-Mellon Univ., Pittsburgh, PA (United States). Dept. of Mechanical Engineering	
	20:30335	DOE/PC/92152–T16
FG22-92PC92526	California Univ., Berkeley, CA (United States)	
	20:28585	DOE/PC/92526–T11
FG22-92PC92527	University of Southern California, Los Angeles, CA (United States). Dept. of Chemical Engineering	
	20:28638	DOE/PC/92527–T10
FG22-92PC92544	Brown Univ., Providence, RI (United States). Div. of Engineering	
	20:28639	DOE/PC/92544–11
	20:28640	DOE/PC/92544–12

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FG22-92PC92547	**Virginia Polytechnic Inst. and State Univ., Blacksburg, VA (United States). Dept. of Mining and Minerals Engineering**	
	20:28586	DOE/PC/92547–9
	20:28587	DOE/PC/92547–T8
FG22-92PC92550	**Kentucky Univ., Lexington, KY (United States). Center for Applied Energy Research**	
	20:28588	DOE/PC/92550–10
FG22-93BC14899	**Stanford Univ., CA (United States). Petroleum Research Inst.**	
	20:28692	DOE/BC/14899–30
FG22-93PC93202	**Alabama Univ., University, AL (United States). Dept. of Chemistry**	
	20:28642	DOE/PC/93202–7
FG22-93PC93206	**Colorado State Univ., Fort Collins, CO (United States). Dept. of Chemistry**	
	20:28643	DOE/PC/93206–7
FG22-93PC93222	**Lehigh Univ., Bethlehem, PA (United States)**	
	20:28655	DOE/PC/93222–6
FG22-94BC14832	**Oklahoma Univ., Norman, OK (United States)**	
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FG22-94BC14970	**Oklahoma Univ., Norman, OK (United States)**	
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FG22-94BC14971	**Oklahoma Univ., Norman, OK (United States)**	
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FG22-94BC14977	**New Mexico Inst. of Mining and Technology, Socorro, NM (United States)**	
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FG22-94MT94010	**Clark Atlanta Univ., GA (United States)**	
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FG22-94MT94011	**Clark Atlanta Univ., GA (United States)**	
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FG22-94MT94013	**North Carolina Agricultural and Technical State Univ., Greensboro, NC (United States). Dept. of Mechanical Engineering**	
	20:28665	DOE/MT/94013–T1
	20:28666	DOE/MT/94013–T2
FG22-94MT94014	**Southern Univ., Baton Rouge, LA (United States). Center for Energy and Environmental Studies**	
	20:28751	DOE/MT/94014–T1
FG22-94PC94119	**Adelphi Univ., Garden City, NY (United States). Dept. of Physics**	
	20:28673	DOE/PC/94119–T5
FG22-94PC94202	**Alaska Univ., Fairbanks, AK (United States). School of Mineral Industry**	
	20:28589	DOE/PC/94202–T3
FG22-94PC94207	**Georgia Inst. of Tech., Atlanta, GA (United States). School of Chemical Engineering**	
	20:28626	DOE/PC/94207–T3
FG49-93CE15600	**S-Cal Research Corp., San Rafael, CA (United States)**	
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	20:31037	ANL–95/14
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	Nuclear Regulatory Commission, Washington, DC (United States). Office of Nuclear Regulatory Research	
	20:29516	NUREG/CR–4667
	Argonne National Lab., IL (United States). Environmental Assessment Div.	
	20:28793	ANL/EAD/TM–22-Draft
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62113	20:31021	OSTI; NTIS; INIS; GPO Dep.	E 1.99:	DE95017157	MF-414
62130	20:30687	OSTI; NTIS; INIS; GPO Dep.	E 1.99:	DE95017837	MF-400
62137	20:30640	OSTI; NTIS; GPO Dep.	E 1.99:	DE95016558	MF-402
62155	20:30198	OSTI; NTIS; GPO Dep.	E 1.99:	DE96000424	MF-402
62173	20:30401	OSTI; NTIS; INIS; GPO Dep.	E 1.99:	DE95017890	MF-414
62179	20:30786	OSTI; NTIS; GPO Dep.	E 1.99:	DE96000414	MF-408
62187	20:31298	OSTI; NTIS; GPO Dep.	E 1.99:	DE96000427	MF-900
62195	20:31114	OSTI; NTIS; GPO Dep.	E 1.99:	DE96000425	MF-410; MF-401
62204	20:28804	OSTI; NTIS; INIS; GPO Dep.	E 1.99:	DE96000415	MF-721
62213	20:31115	OSTI; NTIS; GPO Dep.	E 1.99:	DE96000413	MF-410
62219	20:30280	OSTI; NTIS; GPO Dep.	E 1.99:	DE96000416	MF-403; MF-405
62222	20:30443	OSTI; NTIS; INIS; GPO Dep.	E 1.99:	DE96001158	MF-414
62224	20:29406	OSTI; NTIS; GPO Dep.	E 1.99:	DE96001333	MF-1250
BNL-NUREG–					
52332	20:29774	*See* NUREG/CR–6002			
52431	20:29776	*See* NUREG/CR–6265			
52446	20:28905	*See* NUREG/CR–6305			
62207	20:29521	OSTI; NTIS; INIS; GPO		TI96000421	
CAP–					
123-95P	20:30359	*See* BNL–52292-Vol.3			
124-95P	20:30397	*See* BNL–52292-Vol.4			
125-95P-Vol.5	20:30360	*See* BNL–52292-Vol.5			
CEBAF-R–					
94-004	20:31045	*See* DOE/ER/40150–284			
95-001	20:30994	*See* DOE/ER/40150–299			
CMR–					
95-1	20:30102	*See* DOE/ER/13987–T1			
CNIC–					
00925	20:30504	OSTI; NTIS (US Sales Only); INIS		DE96602015	
00959	20:29465	OSTI; NTIS (US Sales Only); INIS		DE96601988	
CNWRA–					
94-027	20:28906	*See* NUREG/CR–6356			
CONF-8510523–		(Magnet length workshop; Berkeley, CA (United States); 7-8 Oct 1985)			
	20:30483	*See* SSC-SR–1018			
CONF-8705425–		(Workshop in radiological aspects of Superconducting Super Collider (SSC) Operations; Berkeley, CA (United States); 4-6 May 1987)			
	20:30416	*See* SSC-SR–1031			
CONF-8809547–		(Workshop on Siberian snakes for the SSC Collider ring; Berkeley, CA (United States); 7-8 Sep 1988)			
	20:30486	*See* SSC-SR–1036			
CONF-8901118–		(Workshop on triggering and data acquisition for experiments at the Superconducting Super Collider; Toronto (Canada); 16-19 Jan 1989)			
	20:30524	*See* SSC-SR–1039			

Report Number	Abstract Number	Source of Availability	GPO Dep.	Order Number	Distribution Category
CONF-910872–		(Annual Microbeam Analysis Society meeting; San Jose, CA (United States); 4-9 Aug 1991)			
10	20:29994	OSTI; NTIS; GPO Dep.	E 1.99:	DE95016158	MF-404
CONF-9304296–		(National conference on building commissioning; Sacramento, CA (United States); 28-30 Apr 1993)			
1	20:29908	*See* LBL–33934			
CONF-931108–		(Fall meeting of the Materials Research Society (MRS); Boston, MA (United States); 29 Nov - 3 dec 1993)			
115	20:30170	*See* LBL–35470			
CONF-9311199–		(International workshop on research and development of geological disposal; Tokai (Japan); 15-19 Nov 1993)			
	20:28921	*See* PNC-TN–1100-94-002			
CONF-9401125–		(Workshop on towards the unified understanding of elastic and inelastic scattering and transfer reactions; Tanashi (Japan); 6-8 Jan 1994)			
	20:31047	*See* INS-J–180			
CONF-9402156–		(Japan-Russia joint workshop on radiation safety; Tokyo (Japan); 28 Feb - 3 mar 1994)			
	20:31303	*See* INIS-JP–032			
CONF-9403240–		(Artificial Magma Program; Oak Ridge, TN (United States); 29-30 Mar 1994)			
	20:28918	*See* ORNL/TM–13015			
CONF-9404197–		(Workshop on CEBAF at higher energies; Newport News, VA (United States); 14-16 Apr 1994)			
	20:30994	*See* DOE/ER/40150–299			
CONF-9404283–		(PACLIM workshop; Pacific Grove, CA (United States); 19-22 Apr 1994)			
1	20:30875	*See* BNL–62058			
CONF-9404286–		(Synthesis and application of lanthanide-doped ceramics; Cincinnati, OH (United States); 30 Apr - 4 may 1994)			
1	20:30146	*See* SAND–95-2108C			
CONF-940553–		(International high-level radioactive waste management conference; Las Vegas, NV (United States); 22-26 May 1994)			
85	20:30688	OSTI; NTIS; INIS; GPO Dep.	E 1.99:	DE96001451	MF-814
86	20:29010	OSTI; NTIS; INIS; GPO Dep.	E 1.99:	DE96001452	MF-814
87	20:30689	OSTI; NTIS; INIS; GPO Dep.	E 1.99:	DE96001453	MF-814
88	20:30690	OSTI; NTIS; INIS; GPO Dep.	E 1.99:	DE96001454	MF-814
90	20:29011	OSTI; NTIS; INIS; GPO Dep.	E 1.99:	DE96001456	MF-814
91	20:30691	OSTI; NTIS; INIS; GPO Dep.	E 1.99:	DE96001457	MF-814
93	20:29012	OSTI; NTIS; INIS; GPO Dep.	E 1.99:	DE96001459	MF-814
95	20:30692	OSTI; NTIS; INIS; GPO Dep.	E 1.99:	DE96001461	MF-814
96	20:30693	OSTI; NTIS; INIS; GPO Dep.	E 1.99:	DE96001462	MF-814
CONF-9406107–		(1994 Health Physics Society (HPS) summer school on internal dosimetry; Davis, CA (United States); 6 Jun 1994)			
7	20:30820	OSTI; NTIS; INIS; GPO Dep.	E 1.99:	DE95016365	MF-407
CONF-9406184–		(5. SIAM conference on applied linear algebra; Snowbird, UT (United States); 15-18 Jun 1994)			
Final	20:31313	OSTI; NTIS; GPO Dep.	E 1.99:	DE95016992	MF-405
CONF-9406269–		(Snowmass 94: particle and astrophysics in the next millenium; Snowmass, CO (United States); 29 Jun - 14 jul 1994)			
5	20:30905	*See* SLAC-PUB–95-6915			
6	20:31008	*See* LA-UR–95-1822			
CONF-940627–		(4. international conference and exhibition of the World Congress on Superconductivity; Orlando, FL (United States); 27 Jun - 1 jul 1994)			
Vol.2	20:31149	OSTI; NASA Center for AeroSpace Information, 800 Elkridge Landing Road, Linthicum Heights, MD 21090-2934 (United States)		TI95017155	
CONF-940633–		(12. symposium on thermophysical properties; Boulder, CO (United States); 19-24 Jun 1994)			
9	20:30876	OSTI; NTIS; GPO Dep.	E 1.99:	DE95014033	MF-1600

Report Number	Abstract Number	Source of Availability	GPO Dep.	Order Number	Distribution Category
CONF-9406355–		(Society of Automotive Engineers (SAE) in the 90's: hybrid electric vehicles TOPTEC workshop; Southfield, MI (United States); 21 Jun 1994)			
Absts.	20:29973	OSTI; NTIS; GPO Dep.	E 1.99:	DE96001032	MF-1501
CONF-940664–		(ISFNT-3: international symposium on fusion nuclear technology; Los Angeles, CA (United States); 27 Jun - 1 jul 1994)			
37-Rev.1	20:31246	*See* UCRL-JC–117698-Rev.1			
CONF-940714–		(International meeting on synchrotron radiation instrumentation; Stony Brook, NY (United States); 18-22 Jul 1994)			
56	20:30463	*See* LBL–35550			
CONF-9407199–		(2. symposium on joint spectroscopy experiments utilizing JAERI Tandem-booster accelerator; Tokai (Japan); 25-26 Jul 1994)			
	20:31048	*See* JAERI-Conf–95-004			
CONF-9408107–		(American Statistical Association; Toronto (Canada); 14-18 Aug 1994)			
7	20:30694	OSTI; NTIS; GPO Dep.	E 1.99:	DE96000248	MF-402
CONF-940813–		(208. American Chemical Society national meeting; Washington, DC (United States); 21-26 Aug 1994)			
42	20:30162	*See* DOE/ER/45522–3			
43	20:31116	*See* DOE/ER/45522–2			
CONF-940815–		(International nuclear and hazardous waste management conference; Atlanta, GA (United States); 14-18 Aug 1994)			
114	20:29042	OSTI; NTIS; INIS; GPO Dep.	E 1.99:	DE95014030	MF-2020
CONF-9408169–		(American Council for Energy-Efficient Economy (ACEEE) summer conference; Asilomar, CA (United States); 28 Aug - 3 sep 1994)			
8	20:29792	OSTI; NTIS; GPO Dep.	E 1.99:	DE95014036	MF-1321
9	20:29843	*See* LBL–35642			
CONF-9408217–		(1. Arctic workshop on future physics and accelerators; Saariselka (Finland); 21-26 Aug 1994)			
3	20:30412	*See* LBL–37301			
CONF-940867–		(Gordon research conference on photonuclear reactions; Tilton, NH (United States); 1-5 Aug 1994)			
	20:31092	*See* UM-P–94/61			
CONF-940893–		(Summer conference on energy efficiency in buildings; Monterey, CA (United States); 29 Aug - 3 sep 1994)			
19	20:29898	OSTI; NTIS; GPO Dep.	E 1.99:	DE95014031	MF-1600
CONF-940922–		(7. international conference on physics of highly charged ions; Vienna (Austria); 19-23 Sep 1994)			
9	20:30873	*See* UCRL-JC–118362			
CONF-9409301–		(16. international meeting for specialists in air pollution effects on forest ecosystems, air pollution and multiple stresses; New Brunswick (Canada); 7-9 Sep 1994)			
2	20:30677	*See* UCRL-JC–116595			
3	20:30756	*See* UCRL-JC–116594			
CONF-9409366–		(7. seminar of the IIE-ININ-IMP on technological specialities; Distrito Federal (Mexico); 7 Sep 1994)			
	20:31398	*See* INIS-mf–14601			
CONF-9409375–		(National thermal spray conference; Houston, TX (United States); Sep 1994)			
1	20:30032	*See* IS-M–827			
CONF-941011–		(3. international conference on containment design and operation; Toronto (Canada); 19-21 Oct 1994)			
6	20:29579	OSTI; NTIS; INIS		TI95016359	

Report Number	Abstract Number	Source of Availability	GPO Dep.	Order Number	Distribution Category
CONF-9410189–		(Applications of lasers and electro-optics; Orlando, FL (United States); 17-20 Oct 1994)			
1-Rev.1	20:30318	*See* UCRL-JC–117078-Rev.1			
CONF-9410218–		(Pulsed radio frequency sources for linear colliders; Long Island, NY (United States); 2-7 Oct 1994)			
10	20:30477	*See* SLAC-PUB–95-6676			
CONF-9410231–		(8. Deneb user group meeting; Detroit, MI (United States); 10-14 Oct 1994)			
3	20:30281	OSTI; NTIS; INIS; GPO Dep.	E 1.99:	DE95014254	MF-2060
CONF-9410248–		(1994 international workshop on B physics, physics beyond the standard model at the B factory; Nagoya (Japan); 26-28 Oct 1994)			
4	20:30413	*See* SLAC-PUB–95-6757			
5	20:30494	*See* LBL–37307			
CONF-9410254–		(Nuclear explosives code developers conference (NECDC); Las Vegas, NV (United States); 27 Oct 1994)			
9	20:31277	*See* UCRL-JC–121286			
CONF-9410314–		(6. international workshop on radiative properties of hot dense matter; Sarasota, FL (United States); 31 Oct - 4 nov 1994)			
4	20:31195	*See* UCRL-JC–118834			
CONF-9410373–		(In-service training seminar of the International Association of Bomb Technicians and Investigators; Canberra (Australia); 13 Oct 1994)			
	20:29180	*See* UM-P–94/117			
CONF-9410385–		(Spin degrees of freedom in electromagnetic nuclear physics; Williamsburg, VA (United States); 26 Oct 1994)			
	20:31045	*See* DOE/ER/40150–284			
CONF-941061–		(Nuclear science symposium: medical imaging conference; Norfolk, VA (United States); 30 Oct - 5 nov 1994)			
21-Vugraphs	20:30507	*See* EGG–11265-5019			
22	20:30519	*See* LBL–37310			
CONF-941063–		(186. meeting of the Electrochemical Society; Miami, FL (United States); 9-14 Oct 1994)			
14	20:29808	*See* BNL–60541			
CONF-941101–		(Meeting of the Division of Plasma Physics of the American Physical Society; Minneapolis, MN (United States); 7-11 Nov 1994)			
13	20:31196	*See* UCRL-JC–119068			
14	20:31247	*See* UCRL-JC–117814			
CONF-941102–		(Winter meeting of the American Nuclear Society; Washington, DC (United States); 13-18 Nov 1994)			
46	20:28805	OSTI; NTIS; INIS; GPO Dep.	E 1.99:	DE95014032	MF-2000
CONF-9411140–		(Imaging sciences workshop; Livermore, CA (United States); 15-16 Nov 1994)			
Absts.	20:29848	OSTI; NTIS; GPO Dep.	E 1.99:	DE95017252	MF-706
CONF-941115–		(Fall meeting of the Materials Research Society; Boston, MA (United States); 28 Nov - 2 dec 1994)			
2	20:30361	OSTI; NTIS; INIS; GPO Dep.	E 1.99:	DE95014258	MF-411
CONF-9411178–		(6. workshop on use of parallel processors in meterology; Reading (United Kingdom); 24 Nov 1994)			
3	20:30844	*See* ANL/MCS/CP–85860			
CONF-9411182–		(1. international symposium for evaluation of current trends in fusion research; Washington, DC (United States); 14-18 Nov 1994)			
3	20:31248	*See* UCRL-JC–118659			
CONF-9411250–		(1. international future generations forum; Kyoto (Japan); 23-25 Nov 1994)			
1	20:31287	OSTI; NTIS; GPO Dep.	E 1.99:	DE95014029	MF-402

Report Number	Abstract Number	Source of Availability	GPO Dep.	Order Number	Distribution Category
CONF-941128–		(Annual meeting of the American Institute of Chemical Engineers; San Francisco, CA (United States); 13-18 Nov 1994)			
8	20:30079	*See* UCRL-JC–116997			
CONF-941139–		(International workshop on indoor air: an integrated approach; Gold Coast (Australia); 27 Nov - 1 dec 1994)			
3	20:30836	OSTI; NTIS; GPO Dep.	E 1.99:	DE95016363	MF-407
CONF-941142–		(American Society of Mechanical Engineers' winter annual meeting; Chicago, IL (United States); 6-11 Nov 1994)			
35	20:31393	OSTI; NTIS; GPO Dep.	E 1.99:	DE95014045	MF-405
CONF-941144–		(1994 fall meeting of the Materials Research Society (MRS); Boston, MA (United States); 28 Nov - 2 dec 1994)			
173	20:31256	*See* UCRL-JC–120184			
CONF-941182–		(6. international Toki conference on plasma physics and controlled nuclear fusion: Research for advanced concepts in magnetic fusion; Toki-city (Japan); 29 Nov - 2 dec 1994)			
5	20:31155	OSTI; NTIS; INIS; GPO Dep.	E 1.99:	DE95017443	MF-421
CONF-941207–		(Spent nuclear fuel meeting: challenges and initiatives; Salt Lake City, UT (United States); 14-16 Dec 1994)			
38	20:30282	OSTI; NTIS; INIS; GPO Dep.	E 1.99:	DE95016364	MF-610
CONF-941218–		(17. world energy engineering congress and the 4th environmental technology congress and expo; Atlanta, GA (United States); 7-9 Dec 1994)			
10	20:29918	*See* PNL-SA–23973			
CONF-941255–		(Life cycles of energetic materials; Del Mar, CA (United States); 11-16 Dec 1994)			
5	20:30595	*See* UCRL-JC–119253			
CONF-941273–		(Special parallel process workshop; Livermore, CA (United States); 6-7 Dec 1994)			
Suppl.	20:31314	OSTI; NTIS; GPO Dep.	E 1.99:	DE96000061	MF-405
CONF-941280–		(American Geophysical Union fall meeting; San Francisco, CA (United States); 5 Dec 1994)			
1	20:30852	*See* UCRL-JC–118923			
CONF-941287–		(INS workshop 'physics of e^+e^-, $e^-\gamma$ and $\gamma\gamma$ collisions at linear accelerators; Tanashi (Japan); 20-22 Dec 1994)			
	20:30918	*See* INS-J–181			
CONF-941288–		(Symposium on negative ion sources and their applications; Nagoya (Japan); 26-27 Dec 1994)			
	20:30872	*See* NIFS-PROC–24			
CONF-950101–		(Advanced solid-state laser conference; Memphis, TN (United States); 29 Jan - 1 feb 1995)			
9	20:30389	*See* UCRL-JC–118194			
CONF-9501107–		(ACM symposium on discrete algorithms; Atlanta, GA (United States); Jan 1995)			
1	20:31350	*See* LA-UR–95-2925			
CONF-9501108–		(9. joint conference on the applications of air pollution meteorology; Atlanta, GA (United States); 28 Jan - 2 feb 1995)			
1	20:30679	*See* UCRL-JC–121086			
2	20:30678	*See* UCRL-JC–121047			
CONF-950112–		(9. joint workshop on electron cyclotron emission and electron cyclotron resonance heating; Borrego Springs, CA (United States); 23-26 Jan 1995)			
5	20:31213	*See* GA–A22038			
6-Rev.1	20:31161	*See* GA-A–22050-Rev.1			
CONF-950116–		(1995 American Society of Mechanical Engineers (ASME) energy sources technology conference and exhibition; Houston, TX (United States); 29 Jan - 1 feb 1995)			
8	20:29424	*See* NREL/TP–442-6912			

Report Number	Abstract Number	Source of Availability	GPO Dep.	Order Number	Distribution Category
CONF-950125–		(20. annual workshop on geothermal reservoir engineering; Stanford, CA (United States); 24-26 Jan 1995)			
2	20:29418	*See* LA-UR–95-2487			
CONF-950151–		(NATO (ASI)/monitoring a comprehensive test ban treaty; Algrave (Portugal); 23 Jan - 2 feb 1995)			
7	20:30853	*See* UCRL-JC–119218			
CONF-950183–		(Recontres de Moriond workshop; Villar-sur-Ollon (Switzerland); 21-28 Jan 1995)			
4	20:30954	*See* LA-UR–95-2101			
5	20:31031	*See* UCRL-JC–121562			
CONF-950202–		(6. international conference on heavy crude and tar sands; Houston, TX (United States); 11-18 Feb 1995)			
2	20:28706	*See* UCRL-JC–120301			
CONF-9502106–		(Winter workshop on nuclear dynamics; Key West, FL (United States); 11-17 Feb 1995)			
2	20:31083	*See* LBL–37121			
3	20:31082	*See* LBL–37120			
CONF-9502113–		(1995 ACR conference on improving productivity in system development; Phoenix, AZ (United States); 6-10 Feb 1995)			
1	20:31353	*See* LBL–36247			
CONF-9502120–		(Integrated photonics researach conference; Dana Point, CA (United States); 23-25 Feb 1995)			
1	20:30908	*See* UCRL-JC–119957			
CONF-9502121–		(11. annual meeting of the Western Chapter of the Alternative Natural Philosophy Association; Stanford, CA (United States); 18-20 Feb 1995)			
1	20:30864	*See* SLAC-PUB–95-6760			
CONF-9502122–		(2. international workshop in plasma-based ion implantation; Sydney (Australia); 12-15 Feb 1995)			
1	20:29813	*See* LBL–36782			
CONF-9502123–		(1. workshop on utilization of high intensity proton accelerator; Tokai (Japan); 7-8 Feb 1995)			
	20:30399	*See* JAERI-Conf–95-017			
CONF-950216–		(Waste management '95; Tucson, AZ (United States); 26 Feb - 2 mar 1995)			
156	20:29002	*See* WSRC-TR–95-0059			
CONF-950220–		(9. international conference on ion beam modification of materials; Canberra (Australia); 5-10 Feb 1995)			
10	20:30055	*See* LBL–36783			
CONF-950226–		(SPIE '95: SPIE conference on optics, electro-optics, and laser application in science, engineering and medicine; San Jose, CA (United States); 5-14 Feb 1995)			
57	20:31385	*See* UCRL-JC–119787			
CONF-950261–		(Contribution for Halbach Festschrift; Berkeley, CA (United States); 3 Feb 1995)			
5	20:30470	*See* LBL–36620			
CONF-950278–		(Astrophysical applications of stellar pulsation; Cape Town (South Africa); 6-10 Feb 1995)			
2	20:30910	*See* UCRL-JC–120968			
CONF-950287–		(International symposium on vector boson interactions; Los Angeles, CA (United States); 1-3 Feb 1995)			
5	20:31010	*See* LBL–37244			
CONF-9503103–		(NetWorld and Interop '95; Las Vegas, NV (United States); 27-29 Mar 1995)			
2	20:31375	*See* SLAC-PUB–95-6744			
CONF-9503106–		(Goddard conference on mass storage and technolgies; College Park, MD (United States); 28-30 Mar 1995)			
3	20:31383	*See* UCRL-JC–119758			

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CONF-9503158–		(30. Rencontres de Moriond on QCD and high energy interactions; Les Arcs (France); 19-26 Mar 1995)			
16	20:30880	*See* FNAL/C–95/120			
19	20:31015	*See* SLAC-PUB–95-6933			
22	20:31025	*See* FNAL/C–95/223-E			
CONF-9503167–		(1995 International Astronomical Union (IAU) colloquium #152 on astrophysics in the extreme ultraviolet; Berkeley, CA (United States); 27-30 Mar 1995)			
2	20:30911	*See* UCRL-JC–121090			
CONF-9503177–		(comparative study of current methodologies in electron-molecule scattering; Cambridge, MA (United States); 11-13 Mar 1995)			
1	20:31107	*See* LA-UR–95-2878			
CONF-9503181–		(NASA space and earth science data compression workshop; Salt Lake City, UT (United States); 27 Mar 1995)			
1	20:30849	*See* LA-UR–95-1659			
CONF-9503182–		(1995 oil heat technology conference and workshop; Upton, NY (United States); 22-23 Mar 1995)			
	20:28720	*See* BNL–52475			
CONF-9503183–		(Joint meeting of the international symposium on particles, strings and cosmology, and the 19. Johns Hopkins workshop in current problems in particle theory; Baltimore, MD (United States); 22-25 Mar 1995)			
1	20:30957	*See* SLAC-PUB–95-6934			
2	20:30991	*See* SLAC-PUB–95-6937			
CONF-9503190–		(6. new nuclear fuel research meeting, Yayoi Research Group; Tokyo (Japan); 17 Mar 1995)			
	20:29520	*See* UTNL-R–0323			
CONF-9503191–		(6. workshop on dusty plasmas; San Diego, CA (United States); Mar 1995)			
1	20:31183	*See* LA-UR–95-2945			
CONF-950339–		(IMA workshop on inverse problems in wave propagation; Minneapolis, MN (United States); 6-17 Mar 1995)			
1	20:30909	*See* UCRL-JC–120092			
CONF-950401–		(97. annual meeting of the American Ceramic Society; Cincinnati, OH (United States); 30 Apr - 1 may 1995)			
26	20:30092	OSTI; NTIS; GPO Dep.	E 1.99:	DE95014044	MF-1505
27	20:30396	*See* UCRL-JC–121646			
CONF-950402–		(209. American Chemical Society (ACS) national meeting; Anaheim, CA (United States); 2-6 Apr 1995)			
12	20:28590	OSTI; NTIS; GPO Dep.	E 1.99:	DE95016572	MF-108
13	20:28591	OSTI; NTIS; GPO Dep.	E 1.99:	DE95016573	MF-108
15	20:30153	*See* ANL/CMT/CP–84718			
CONF-950412–		(Spring meeting of the Materials Research Society (MRS); San Francisco, CA (United States); 17-21 Apr 1995)			
35	20:30080	*See* UCRL-JC–118964			
39	20:30517	*See* LBL–37082			
43	20:30368	*See* LBL–37267			
45	20:30090	*See* ANL/MSD/CP–83317			
53	20:29814	*See* UCRL-JC–120314			
54	20:30165	*See* IS-M–825			
55	20:30237	*See* LA-UR–95-1975			
CONF-9504154–		(Symposium on autonomous vehicles in mine countermeasures; Monterey, CA (United States); 3-7 Apr 1995)			
3	20:30554	*See* UCRL-JC–120550			
4	20:30580	*See* UCRL-JC–120710			
CONF-9504160–		(1995 DOE/NREL hydrogen program review; Coral Gables, FL (United States); 18-21 Apr 1995)			
8	20:30188	*See* UCRL-JC–120315			

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CONF-9504165–		(12. international workshop on ECR ion sources; Riken (Japan); 25-27 Apr 1995)			
3	20:30471	*See* LBL–37311			
CONF-9504179–		(6. annual international conference on high level radioactive waste management; Las Vegas, NV (United States); 30 Apr - 5 may 1995)			
4	20:28892	*See* LBL–36527			
CONF-9504192–		(15. annual hydrology days conference; Ft. Collins, CO (United States); 3-7 Apr 1995)			
1	20:28962	*See* PNL-SA–25595			
CONF-9504197–		(5. National transportation planning methods applications conference; Seattle, WA (United States); 17-21 Apr 1995)			
1	20:29921	*See* LA-UR–95-1664			
CONF-9504198–		(AIP workshop on high velocity neutron stars; La Jolla, CA (United States); 15 Apr 1995)			
1	20:30891	*See* LA-UR–95-1735			
CONF-950420–		(International conference on mathematics and computations, reactor physics, and environmental analyses; Portland, OR (United States); 30 Apr - 4 may 1995)			
31	20:29036	*See* WHC-SA–2665			
32	20:31382	*See* UCRL-JC–119752			
CONF-9504204–		(Advanced visual systems conference; Boston, MA (United States); 19-21 Apr 1995)			
1	20:31355	*See* LBL–36775			
CONF-9504206–		(Workshop on Tibet cosmic ray experiment and related physics topics; Beijing (China); 4-13 Apr 1995)			
1	20:31030	*See* LBL–37532			
CONF-950426–		(3. international conference on nuclear engineering; Kyoto (Japan); 23-27 Apr 1995)			
5	20:29486	*See* ANL/ET/CP–82776			
CONF-950430–		(5. ANS topical meeting on emergency preparedness and response; Savannah, GA (United States); 18-21 Apr 1995)			
10	20:30843	*See* EGG–11265-1124			
11	20:30633	*See* EGG–11265-1125			
12	20:31317	*See* EGG–11265-1130			
13	20:29086	*See* EGG–11265-1122			
CONF-950434–		(International topical meeting on safety culture in nuclear installations; Vienna (Austria); 24-28 Apr 1995)			
3	20:30288	*See* INEL–95/00079			
4	20:29091	*See* INEL–95/00080			
CONF-950454–		(22. international AVS conference on metallurgical coatings and thin films; San Diego, CA (United States); 24-28 Apr 1995)			
9	20:30118	*See* LBL–36166			
CONF-950455–		(9. international conference on vehicle structural mechanics and computer-aided engineering; Troy, MI (United States); 4-6 Apr 1995)			
2	20:30081	*See* UCRL-JC–119956			
CONF-950483–		(3. international symposium on in situ and on-site bioreclamation; San Diego, CA (United States); 24-27 Apr 1995)			
7	20:30757	*See* UCRL-JC–118024			
CONF-950494–		(Natural gas research, development and demonstration contractors review meeting; Baton Rouge, LA (United States); 4-6 Apr 1995)			
34	20:28740	*See* DOE/MC/30088–95/C0474			
35	20:28754	*See* DOE/MC/31114–95/C0487			
36	20:28701	*See* DOE/MC/31197–95/C0472			
CONF-950506–		(5. topical meeting on tritium technology in fission, fusion and isotopic applications; Ispra (Italy); 28 May - 3 jun 1995)			
16	20:30311	*See* PPPL-CFP–3349			
CONF-9505101–		(Conference on challenges and innovations in the management of hazardous waste; Washington, DC (United States); 10-12 May 1995)			
9	20:29108	*See* PNL-SA–26246			

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CONF-9505105–		(11. topical conference on radio frequency in plasmas; Palm Springs, CA (United States); 17-19 May 1995)			
14	20:31214	*See* GA-A–22081			
16	20:31156	OSTI; NTIS; INIS; GPO Dep.	E 1.99:	DE95017386	MF-421
17	20:31204	OSTI; NTIS; INIS; GPO Dep.	E 1.99:	DE95017400	MF-420
CONF-950512–		(Particle accelerator conference; Dallas, TX (United States); 1-5 May 1995)			
286	20:30868	*See* ANL/PHY/CP–86667			
297	20:31250	*See* UCRL-JC–119359			
298	20:30466	*See* LBL–36444			
299	20:31227	*See* LBL–36541			
301	20:30501	*See* UCRL-JC–119208			
305	20:30444	OSTI; NTIS; INIS; GPO Dep.	E 1.99:	DE95013976	MF-411
310	20:30452	*See* LA-UR–95-1578			
312	20:30453	*See* LA-UR–95-1793			
313	20:30435	*See* SLAC-PUB–95-6847			
314	20:30436	*See* SLAC-PUB–95-6856			
315	20:30384	*See* SLAC-PUB–95-6835			
316	20:30498	*See* SLAC-PUB–95-6818			
317	20:30804	*See* LBL–37193			
318	20:31229	*See* LBL–36622			
319	20:30430	*See* LBL–36576			
320	20:30427	*See* LBL–36440			
321	20:31354	*See* LBL–36540			
322	20:30366	*See* LBL–37151			
323	20:30429	*See* LBL–36458			
324	20:31228	*See* LBL–36542			
325	20:30488	*See* UCRL-JC–119360			
326	20:30487	*See* UCRL-JC–119358			
327	20:30420	*See* FNAL/C–95/268			
328	20:30478	*See* SLAC-PUB–95-6798			
329	20:30479	*See* SLAC-PUB–95-6803			
330	20:30476	*See* SLAC–95-6811			
331	20:31254	*See* UCRL-JC–119583			
332	20:31251	*See* UCRL-JC–119538			
333	20:30624	*See* UCRL-JC–119387			
334	20:30365	*See* LBL–37147			
335	20:30421	*See* FNAL/C–95/269			
336	20:30465	*See* LBL–36442			
337	20:30493	*See* LBL–36434			
338	20:31252	*See* UCRL-JC–119539			
339	20:31253	*See* UCRL-JC–119579			
340	20:30428	*See* LBL–36443			
341	20:30426	*See* LBL–36435			
342	20:30467	*See* LBL–36538			
CONF-9505122–		(International conference on ion beam analysis; Tempe, AZ (United States); 22-26 May 1995)			
3	20:30197	*See* ANL/CHM/CP–85678			
7	20:30093	OSTI; NTIS; GPO Dep.	E 1.99:	DE95017446	MF-1401
8	20:29172	*See* LBL–36645			
CONF-9505137–		(10. topical workshop on proton-antiproton collider physics; Batavia, IL (United States); 9-13 May 1995)			
3	20:30996	*See* FNAL/C–95/152-E			
8	20:31028	*See* FNAL/C–162-E			
9	20:30963	*See* FNAL/C–95/192-E			
12	20:31024	*See* FNAL/C–95/211-E			
22	20:30992	*See* SLAC-PUB–95-6960			
24	20:31011	*See* LBL–37507			
25	20:30998	*See* FNAL/C–95/174-E			
26	20:31023	*See* FNAL/C–95/190-E			
CONF-9505171–		(Comprehensive photovoltaic system design seminar; Camarillo, CA (United States); 15-19 May 1995)			
2	20:30437	*See* SLAC-PUB–95-6936			
CONF-950518–		(187. meeting of the Electrochemical Society; Reno, NV (United States); 21-26 May 1995)			
15	20:30189	*See* UCRL-JC–120817			

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CONF-9505204–		(9. annual conference on fossil energy materials; Oak Ridge, TN (United States); 16-18 May 1995)			
	20:29991	*See* ORNL/FMP–95/1			
11	20:30155	OSTI; NTIS; GPO Dep.	E 1.99:	DE95014252	MF-113
12	20:29995	OSTI; NTIS; GPO Dep.	E 1.99:	DE95014253	MF-113
13	20:30119	*See* LBL–37091			
CONF-9505227–		(17. ERSADA symposium on safeguards and nuclear material management; Aachen (Germany); 9-11 May 1995)			
4	20:29148	*See* UCRL-JC–120848			
CONF-9505238–		(NATO international scientific exchange program advanced research workshop; St. Petersburg (Russian Federation); 14-17 May 1995)			
4	20:30321	*See* UCRL-JC–120907			
CONF-9505249–		(97. American Ceramic Society (ACS) annual meeting and exposition; Cincinnati, OH (United States); 2 May 1995)			
11	20:28997	*See* WSRC-MS–94-0640			
12	20:31120	*See* LA-UR–95-1848			
13	20:30547	*See* LBL–37536			
CONF-9505254–		(International stellarator workshop; Madrid (Spain); 22-26 May 1995)			
4	20:31157	OSTI; NTIS; INIS; GPO Dep.	E 1.99:	DE95017385	MF-421
5	20:31205	OSTI; NTIS; INIS; GPO Dep.	E 1.99:	DE95017383	MF-421
CONF-9505257–		(International workshop on computational electronics; Portland, OR (United States); 18-20 May 1995)			
1	20:30370	*See* PNL-SA–24317			
CONF-9505261–		(43. American Society of Mass Spectrometry (ASMS) conference on mass spectrometry and allied topics; Atlanta, GA (United States); 21-26 May 1995)			
2	20:29919	*See* UCRL-JC–119269			
CONF-9505264–		(1. annual solid-state lasers for application to inertial confinement fusion meeting; Monterey, CA (United States); 30 May - 2 jun 1995)			
2	20:31271	*See* UCRL-JC–121148			
3	20:31257	*See* UCRL-JC–120185			
4	20:31270	*See* UCRL-JC–121128			
6	20:31259	*See* UCRL-JC–120203			
11	20:31278	*See* UCRL-JC–121452			
12	20:31199	*See* UCRL-JC–121197			
13	20:31269	*See* UCRL-JC–121127			
14	20:31267	*See* UCRL-JC–120887			
15	20:31264	*See* UCRL-JC–120707			
16	20:31263	*See* UCRL-JC–120520			
17	20:31268	*See* UCRL-JC–121125			
18	20:31245	*See* UCRL-JC–117365			
19	20:31255	*See* UCRL-JC–120175			
20	20:31260	*See* UCRL-JC–120213			
21	20:31266	*See* UCRL-JC–120780			
22	20:31272	*See* UCRL-JC–121180			
23	20:31273	*See* UCRL-JC–121195			
24	20:31261	*See* UCRL-JC–120220			
25-Rev.1	20:30391	*See* UCRL-JC–120187-Rev.1			
26	20:31274	*See* UCRL-JC–121198			
27	20:31275	*See* UCRL-JC–121271			
28	20:30394	*See* UCRL-JC–121614			
29	20:31284	*See* UCRL-JC–121817			
30	20:31249	*See* UCRL-JC–119019			
CONF-9505265–		(46. international appliance technical conference; Urbana, IL (United States); 15-17 May 1995)			
1	20:29911	*See* LBL–36658			
CONF-9505266–		(Planetary defense workshop; Livermore, CA (United States); 22-26 May 1995)			
3	20:30581	*See* UCRL-JC–121595			
CONF-9505270–		(3. international workshop on advanced plasma tools; San Jose, CA (United States); 3-4 May 1995)			
1	20:31198	*See* UCRL-JC–120413			

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CONF-9505271--		(ICF workshop on beam-beam issues for multi-bunch, high-luminosity circular colliders; Dubna (Russian Federation); 18-20 May 1995)			
1	20:30499	*See* SLAC-PUB--95-6954			
CONF-9505272--		(7. international conference on fluid flow in porous media; St. Etienne (France); May 1995)			
1	20:30722	*See* LA-UR--95-2707			
CONF-9505277--		(Duke Engineering and Services, Inc. conference; Charlotte, NC (United States); 24 May 1995)			
1-Vugraphs	20:29577	*See* ANL/TD/CP--87020			
CONF-9505279--		(Fuel cell technology forum; Boston, MA (United States); 16 May 1995)			
1	20:29887	*See* DOE/MC/28055--95/C0493			
CONF-9505280--		(International symposium on particle theory and phenomenology; Ames, IA (United States); 22-24 May 1995)			
3	20:30955	*See* LA-UR--95-2894			
4	20:30965	*See* FNAL/C--95/277-E			
CONF-9505284--		(11. topical conference on radio frequency power in plasmas; Palm Springs, CA (United States); 17-19 May 1995)			
1	20:31206	OSTI; NTIS; INIS; GPO Dep.	E 1.99:	DE95017416	MF-426
3	20:31207	OSTI; NTIS; INIS; GPO Dep.	E 1.99:	DE95017414	MF-420
CONF-9505285--		(Workshop on development and applications of free electron lasers; Beijing (China); 20 May - 6 jun 1995)			
1	20:30403	*See* LA-UR--95-3018			
CONF-9505286--		(Digital signal processing conference and exposition; San Jose, CA (United States); 15-19 May 1995)			
1	20:31318	*See* EGG--11265-5031			
CONF-9505288--		(5. international conference on quasicrystals; Avignon (France); 22-26 May 1995)			
1	20:30031	*See* IS-M--826			
CONF-9505289--		(Super symmetry conference; Palaiseau (France); 15-19 May 1995)			
1	20:30990	*See* LBL--37425			
CONF-9505290--		(8. international precision engineering seminar; Compiegne (France); 15-19 May 1995)			
1	20:30564	*See* UCRL-JC--120825			
CONF-9505291--		(7. European symposium on semiconductor detectors; Schloss Elmau (Germany); 7-10 May 1995)			
1	20:30518	*See* LBL--37243			
CONF-9505292--		(Regional seminar on public information of nuclear energy; Habana (Cuba); 17-19 May 1995)			
	20:29126	*See* INIS-mf--14576			
	20:29859	*See* INIS-mf--14566			
	20:29860	*See* INIS-mf--14568			
	20:29861	*See* INIS-mf--14572			
	20:29862	*See* INIS-mf--14573			
	20:29863	*See* INIS-mf--14574			
	20:29864	*See* INIS-mf--14575			
	20:31306	*See* INIS-mf--14569			
	20:31307	*See* INIS-mf--14570			
CONF-950534--		(Conference on real-time computer applications in nuclear, particle and plasma physics (RT); East Lansing, MI (United States); 22-26 May 1995)			
5	20:30508	*See* FNAL/C--95/141-E			
CONF-950542--		(14. international symposium on thermal treatment technologies: incineration conference; Seattle, WA (United States); 8-12 May 1995)			
4	20:28961	*See* PNL-SA--25207			

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CONF-950576–		(9. European symposium on gravity-dependent phenomena in physical sciences; Berlin (Germany); 2-5 May 1995)			
1	20:30300	*See* LBL–37505			
CONF-950585–		(13. NREL photovoltaics program review meeting; Lakewood, CO (United States); 16-19 May 1995)			
3	20:29395	*See* NREL/TP–442-8108			
CONF-950587–		(17. symposium on biotechnology for fuels and chemicals; Vail, CO (United States); 7-11 May 1995)			
3	20:29246	*See* DOE/CE/15594–T8			
4	20:29377	OSTI; NTIS; GPO Dep.	E 1.99:	DE95017419	MF-1312
CONF-950596–		(Conference on measurement of toxic and related air pollutants; Durham, NC (United States); 2-5 May 1995)			
1	20:30695	OSTI; NTIS; GPO Dep.	E 1.99:	DE95016355	MF-408
CONF-9506112–		(Environmental Protection Agency (EPA) symposium on greenhouse gas emissions and mitigation research; Washington, DC (United States); 27-29 Jun 1995)			
1	20:29826	*See* BNL–61934			
CONF-9506125–		(6. international symposium on heavy flavour physics; Pisa (Italy); 6-9 Jun 1995)			
1	20:31026	*See* FNAL/C–95-237-E			
4	20:31021	*See* BNL–62113			
CONF-9506150–		(2. annual Department of Energy defense programs packaging workshop; San Francisco, CA (United States); 12-15 Jun 1995)			
7	20:28784	*See* WHC-SA–2781			
CONF-9506175–		(Computer-based human support systems: technology, methods and future; Philadelphia, PA (United States); 25-29 Jun 1995)			
5	20:29523	*See* INEL–95/00174			
CONF-9506177–		(Window innovations conference; Toronto (Canada); 8-9 Jun 1995)			
3	20:29912	*See* LBL–36975			
CONF-9506186–		(Workshop on the Tau/Charm Factory; Argonne, IL (United States); 21-23 Jun 1995)			
1	20:31014	*See* SLAC-PUB–95-6916			
CONF-9506191–		(6. international meeting on statistical climatology; Galway (Ireland); Jun 1995)			
4	20:30680	*See* UCRL-JC–121202			
CONF-9506226–		(12. American Society for Surface Mining and Reclamation annual meeting: decades later - a time for reassessment; Gillette, WY (United States); 3-8 Jun 1995)			
1	20:30706	*See* EGG–11265-2019			
CONF-9506229–		(Protection and management of plutonium; Philadelphia, PA (United States); 26-30 Jun 1995)			
1	20:29128	*See* LA-UR–95-1660			
CONF-9506231–		(1995 Energy Systems Division meeting; Argonne, IL (United States); 6-7 Jun 1995)			
10-Vugraphs	20:29363	*See* ANL/ES/VU–87091			
CONF-9506238–		(7. Rochester conference on coherence and quantum optics; Rochester, NY (United States); 7-10 Jun 1995)			
1	20:31258	*See* UCRL-JC–120189			
2	20:31349	*See* LA-UR–95-2836			
CONF-950624–		(Annual meeting of the American Society of Heating, Refrigeration and Air-Conditioning Engineers, Inc. (ASHRAE); San Diego, CA (United States); 24-28 Jun 1995)			
1	20:30171	*See* LBL–37481			
3	20:29910	*See* LBL–36636			
5	20:29899	OSTI; NTIS; GPO Dep.	E 1.99:	DE95014251	MF-1423

Report Number	Abstract Number	Source of Availability	GPO Dep.	Order Number	Distribution Category
CONF-9506242--		(International workshop on advanced fusion science research; Taejeon (Korea, Republic of); 21-24 Jun 1995)			
2	20:31191	*See* PPPL-CFP-3350			
CONF-9506245--		(NATO meeting on nuclear submarine decommissioning and related problems: Moscow (Russian Federation); 19-22 Jun 1995)			
1	20:28963	*See* PNL-SA-26402			
CONF-9506249--		(Advanced Accelerator Physics school; Beijing (China); 14-17 Jun 1995)			
1	20:30869	*See* BNL-62048			
CONF-9506250--		(RICH '95: workshop on ring imaging detectors; Uppsala (Sweden); 12-16 Jun 1995)			
1	20:30503	*See* BNL-62065			
2	20:30523	*See* SLAC-PUB-95-6968			
CONF-9506254--		(ROK-Canada arms control workshop; Seoul (Korea, Republic of); 7-9 Jun 1995)			
1	20:29982	*See* SAND-95-1650C			
CONF-9506256--		(8. international solar wind conference; Dana Point, CA (United States); 26-30 Jun 1995)			
1	20:30893	*See* LA-UR-95-2664			
2	20:30897	*See* LA-UR-95-2888			
3	20:30895	*See* LA-UR-95-2853			
4	20:30898	*See* LA-UR-95-2969			
5	20:30901	*See* LA-UR-95-3128			
CONF-9506258--		(Chinese-American Academic and Professional Association in United States (CAPASUS) conference; Atlanta, GA (United States); 23-25 Jun 1995)			
1	20:30787	OSTI; NTIS; GPO Dep.	E 1.99:	DE95017392	MF-406; MF-408
CONF-9506262--		(12. international conference on laser spectroscopy; Piza (Italy); 11-16 Jun 1995)			
1	20:30902	*See* LBL-37389			
CONF-9506263--		(Nonlinear dynamics in optical systems; Rochester, NY (United States); 7-10 Jun 1995)			
1	20:30367	*See* LBL-37249			
CONF-9506265--		(Summer study of the European Council for an Energy-Efficient Economy; Mandelieu (France); 6-10 Jun 1995)			
1	20:29956	*See* LBL-36647			
CONF-9506266--		(International workshop on aged and decommissioned material collection and testing for structural integrity purposes; Mol (Belgium); 27-28 Jun 1995)			
1	20:29502	OSTI; NTIS; GPO Dep.	E 1.99:	DE95017442	MF-406
CONF-9506267--		(9. conversation in biomolecular stereodynamics; Albany, NY (United States); 20-24 Jun 1995)			
1	20:30790	*See* LA-UR-95-2962			
CONF-9506268--		(University of Vienna symposium; Vienna (Austria); 25-28 Jun 1995)			
1	20:30865	*See* UCRL-JC-122100			
CONF-9506270--		(IAU colloquium No. 158: cataclysmic variables and related objects; Keele (United Kingdom); 26-30 Jun 1995)			
1	20:30915	*See* UCRL-JC-121827			
CONF-9506271--		(3. international symposium on mine mechanization and automation; Golden, CO (United States); 12-14 Jun 1995)			
1	20:30884	*See* INEL-95/00106			
CONF-950637--		(International workshop on superconductivity: controlled processing of high temperature superconductors - fundamentals and applications; Maui, HI (United States); 18-21 Jun 1995)			
4	20:30091	*See* ANL/MSD/CP-85650			
CONF-950643--		(7. national demand-side management conference: delivering customer value; Dallas, TX (United States); 28-30 Jun 1995)			
3	20:29875	OSTI; NTIS; GPO Dep.	E 1.99:	DE95014034	MF-1320

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CONF-950646–		(Air and Waste Management Association meeting; San Antonio, TX (United States); 18-23 Jun 1995)			
25	20:30685	*See* ANL/ES/CP–85526			
27	20:29038	*See* ANL/EA/CP–84187			
CONF-950682–		(4. international conference on trends in welding research; Gatlinburg, TN (United States); 5-9 Jun 1995)			
2	20:30313	*See* SAND–95-1149C			
3	20:30082	*See* UCRL-JC–120345			
CONF-950691–		(14. international conference on magnet technology; Tampere (Finland); 11-16 Jun 1995)			
14	20:31262	*See* UCRL-JC–120364			
16	20:30491	*See* BNL–61894			
17	20:30431	*See* LBL–37340			
18	20:30500	*See* UCRL-JC–119082			
19	20:30489	*See* UCRL-JC–119406			
20	20:30464	*See* LBL–36342			
21	20:30469	*See* LBL–36562			
22	20:30468	*See* LBL–36561			
CONF-950702–		(Joint meeting of the American Association of Physicists in Medicine and the Health Physics Society; Boston, MA (United States); 23-27 Jul 1995)			
2	20:31044	*See* PNL-SA–25608			
CONF-950704–		(22. European conference on controlled fusion and plasma physics; Bournemouth (United Kingdom); 2-7 Jul 1995)			
11	20:31181	*See* LA-UR–95-2820			
12	20:31234	*See* ORNL/TM–13009			
CONF-950705–		(HEP 95: international Europhysics conference on high-energy physics; Brussels (Belgium); 21-27 Jul 1995)			
9	20:30966	*See* FNAL/C–212-E			
17	20:31016	*See* SLAC-PUB–95-7004			
18	20:31000	*See* FNAL/C–95/205-E			
19	20:30964	*See* FNAL/C–95/259-E			
20	20:31022	*See* FNAL/C–95/184-E			
CONF-950706–		(19. international conference on the physics of electronic and the atomic collisions; Whistler (Canada); 26 Jul - 1 aug 1995)			
18	20:30874	*See* UCRL-JC–122108			
CONF-950708–		(11. international conference on solid state dosimetry; Budapest (Hungary); 10-14 Jul 1995)			
1	20:30808	*See* SLAC-PUB–95-6939			
CONF-9507119–		(Summer national meeting of the American Institute of Chemical Engineers; Boston, MA (United States); 30 Jul - 2 aug 1995)			
1	20:30683	*See* WHC-SA–2885			
CONF-950713–		(6. international symposium on fracture mechanics of ceramics; Karlsruhe (Germany); 18-20 Jul 1995)			
1	20:30148	*See* SAND–95-2192C			
CONF-9507140–		(13. annual system safety conference: the hazard control methodologies for the future; San Jose, CA (United States); 12-17 Jul 1995)			
2	20:29109	*See* PNL-SA–26423			
CONF-9507141–		(Laser techniques for state selected and state-to-state chemistry III; San Diego, CA (United States); 11-14 Jul 1995)			
2	20:30226	*See* SAND–95-8633C			
CONF-9507147–		(1995 ultrasonics international conference; Edinburgh (United Kingdom); 4-7 Jul 1995)			
2	20:29990	*See* LA-UR–95-2841			
CONF-9507148–		(9. annual conference and equipment exhibit of the American Glovebox Society; Minneapolis, MN (United States); 19-25 Jul 1995)			
4	20:30296	*See* LA-UR–95-2494			

Report Number	Abstract Number	Source of Availability	GPO Dep.	Order Number	Distribution Category
CONF-9507150–		(11. annual waste testing and quality assurance symposium; Washington, DC (United States); 23-28 Jul 1995)			
2	20:28806	OSTI; NTIS; INIS; GPO Dep.	E 1.99:	DE95016346	MF-2000
3	20:29037	*See* ANL/CMT-ACL/CP–85701			
CONF-9507152–		(20. international symposium on shock waves; Pasadena, CA (United States); 24-28 Jul 1995)			
4	20:31244	*See* UCRL-JC–12065			
CONF-9507157–		(3. international symposium on air-water gas transfer; Heidelberg (Germany); 24-27 Jul 1995)			
1	20:30904	*See* PNL-SA–25847			
CONF-9507158–		(12. office information technology conference; Augusta, GA (United States); 17-20 Jul 1995)			
1	20:31408	*See* PNL-SA–26339			
CONF-9507159–		(11. annual coal preparation, utilization, and environmental control contractors conference; Pittsburgh, PA (United States); 12-14 Jul 1995)			
	20:28576	OSTI; NTIS; GPO; INIS; GPO Dep.	E 1.99:	DE95017240	MF-102; MF-104; MF-105; MF-113;
CONF-9507166–		(Graphicon '95; St. Petersburg (Russian Federation); 5-7 Jul 1995)			
1	20:31347	*See* LA-UR–95-1766			
CONF-9507169–		(Whole earth telescope workshop; Ames, IA (United States); Jul 1995)			
1	20:30899	*See* LA-UR–95-3005			
CONF-9507170–		(Advances in X-ray analysis; Denver, CO (United States); Jul 1995)			
1	20:30049	*See* LA-UR–95-3126			
2	20:30048	*See* LA-UR–95-3125			
CONF-9507171–		(Experimental and numerical methods for solving ill-posed problems; San Diego, CA (United States); 9-14 Jul 1995)			
1	20:30805	*See* LBL–37402			
CONF-9507172–		(18. international conference on defects in semiconductors; Sendai (Japan); 23-28 Jul 1995)			
1	20:30238	*See* LBL–36875			
2	20:30172	*See* LBL–37525			
CONF-9507174–		(Interferometry VII applications; Tucson, AZ (United States); 14 Jul 1995)			
1	20:31265	*See* UCRL-JC–120767			
CONF-9507175–		(44. annual Denver x-ray conference; Colorado Springs, CO (United States); 31 Jul - 4 aug 1995)			
1	20:30149	*See* SAND–95-2254C			
CONF-9507176–		(Space cryogenics workshop; Greenbelt, MD (United States); 25-26 Jul 1995)			
1	20:31153	*See* SAND–95-1385C			
CONF-9507177–		(9. Protein Society symposium; Boston, MA (United States); 8-12 Jul 1995)			
1	20:30789	*See* LA-UR–95-2785			
CONF-9507178–		(SPIE electron beam sources of high-brightness radiation; San Diego, CA (United States); 9-14 Jul 1995)			
1	20:30401	*See* BNL–62173			
CONF-9507179–		(Parallel CFD; Pasadena, CA (United States); Jul 1995)			
1	20:30661	*See* LA-UR–95-2794			
2	20:30894	*See* LA-UR–95-2783			
CONF-9507180–		(3. international workshop on B-physics at hadron machines; Oxford (United Kingdom); 10-14 Jul 1995)			
1	20:31027	*See* FNAL/C–95/288			

Report Number	Abstract Number	Source of Availability	GPO Dep.	Order Number	Distribution Category
CONF-9507182–		(European Physical Society conference; Bournmouth (United Kingdom); 3-7 Jul 1995)			
1	20:31208	*See* DOE/CH/03073–T74			
CONF-950722–		(Cryogenic engineering conference and international cryogenic materials conference; Columbus, OH (United States); 17-21 Jul 1995)			
6	20:30870	*See* LA-UR–95-2463			
7	20:31151	*See* LA-UR–95-2461			
8	20:29191	*See* LA-UR–95-2462			
CONF-950727–		(Summer meeting of the IEEE Power Engineering Society; Portland, OR (United States); 23-27 Jul 1995)			
3	20:29788	*See* PNL-SA–25692			
CONF-950729–		(30. Intersociety energy conversion conference; Orlando, FL (United States); 30 Jul - 5 aug 1995)			
12	20:29881	*See* PNL-SA–26326			
CONF-950739–		(3. Alfred conference on fractography of glasses and ceramics; Alfred, NY (United States); 9-12 Jul 1995)			
1	20:30350	*See* SAND–94-3230C			
CONF-950740–		(Joint ASME/JSME pressure vessels and piping conference; Honolulu, HI (United States); 23-27 Jul 1995)			
48	20:28803	*See* BNL–61646			
78	20:29992	*See* ANL/ET/CP–84133			
80	20:29580	OSTI; NTIS; INIS; GPO Dep.	E 1.99:	DE95017404	MF-413
85	20:29450	*See* ANL/ET/CP–83023			
86	20:28801	*See* ANL/RE/CP–85598			
87	20:30332	*See* ANL/ET/CP–84666			
90	20:29576	*See* ANL/RE/CP–85604			
92	20:30322	*See* UCRL-JC–121076			
93	20:30324	*See* UCRL-JC–121331			
94-Pt.1	20:30325	*See* UCRL-JC–121345-Pt.1			
95	20:30320	*See* UCRL-JC–120535			
96-Rev.1	20:29034	*See* UCRL-JC–119435-Rev.1			
97-Pt.2	20:29920	*See* UCRL-JC–121345-Pt.2			
98	20:28986	*See* UCRL-JC–121447			
99	20:30287	*See* INEL–94/00106			
CONF-950750–		(10. Institute of Electrical and Electronics Engineers (IEEE) pulsed power conference; Albuquerque, NM (United States); 10-13 Jul 1995)			
19	20:30295	*See* LA-UR–95-2322			
21	20:30364	*See* LA-UR–95-2552			
33	20:30390	*See* UCRL-JC–119362			
34	20:31224	*See* LA-UR–95-2816			
35	20:31223	*See* LA-UR–95-2815			
36	20:31185	*See* LA-UR–95-3106			
37	20:30896	*See* LA-UR–95-2869			
38	20:31235	*See* SAND–94-3136C			
39	20:30490	*See* UCRL-JC–119582			
40	20:31225	*See* LA-UR–95-2868			
42	20:29171	*See* LA-UR–95-3035			
CONF-950778–		(ACM conference on computational learning theory; Santa Cruz, CA (United States); Jul 1995)			
2	20:30758	*See* UCRL-JC–119863			
CONF-950786–		(3. annual conference on the recycle and reuse of radioactive scrap metal; Knoxville, TN (United States); 31 Jul - 3 aug 1995)			
3	20:28707	*See* ANL/EA/CP–86378			
CONF-950787–		(36. annual meeting of the Institute for Nuclear Materials Management; Palm Desert, CA (United States); 9-12 Jul 1995)			
20	20:29140	*See* SAND–95-1451C			
26	20:29151	*See* WHC-SA–2834			
52	20:29139	*See* SAND–95-1450C			
55	20:30203	*See* LA-UR–95-1805			
57	20:30571	*See* SAND–95-1433C			

Report Number	Abstract Number	Source of Availability	GPO Dep.	Order Number	Distribution Category
58	20:30570	*See* SAND–95-1329C			
59	20:29150	*See* WHC-SA–2831			
63	20:29983	*See* LA-UR–95-2333			
74	20:29152	*See* WHC-SA–2902			
82	20:29149	*See* UCRL-JC–121564			
83	20:28982	*See* UCRL-JC–119891			
84	20:29477	*See* SAND–95-1991C			
86	20:28847	*See* INEL–95/00320			
CONF-950793–		(40. annual meeting of the Society of Photo-Optical Instrumentation Engineers; San Diego, CA (United States); 9-14 Jul 1995)			
16	20:30561	*See* BNL–61989			
17	20:30546	*See* LA-UR–95-2407			
18	20:30363	*See* LA-UR–95-2408			
19	20:31179	*See* LA-UR–95-2459			
20	20:31281	*See* UCRL-JC–121586			
27	20:30168	*See* LA-UR–95-2729			
28	20:30548	*See* SAND–95-1671C			
29	20:31201	*See* UCRL-JC–121582			
32	20:30515	*See* LA-UR–95-2657			
33	20:30539	OSTI; NTIS; GPO Dep.	E 1.99:	DE95014046	MF-404
37	20:31200	*See* UCRL-JC–121200			
38	20:31283	*See* UCRL-JC–121652			
39	20:30193	*See* UCRL-JC–121658			
40	20:30388	*See* UCRL-JC–118103			
42	20:30393	*See* UCRL-JC–120920			
43	20:30914	*See* UCRL-JC–121670			
44	20:31197	*See* UCRL-JC–119326			
45	20:30556	*See* UCRL-JC–121622			
46	20:30353	*See* UCRL-JC–120330			
47	20:31203	*See* UCRL-JC–121629			
48	20:30327	*See* UCRL-JC–121619			
CONF-950798–		(International symposium on metastable, mechanically alloyed and nanocrystalline materials; Quebec City (Canada); 24-28 Jul 1995)			
1	20:30115	*See* LA-UR–95-2653			
CONF-950804–		(13. international conference on structural mechanics in reactor technology; Porto Alegre (Brazil); 13-18 Aug 1995)			
6	20:29575	*See* ANL/RE/CP–84097			
9	20:29778	*See* UCRL-JC–120805			
CONF-9508104–		(2. meeting on biomass of the Americas; Portland, OR (United States); 21-24 Aug 1995)			
2	20:29343	OSTI; NTIS; GPO Dep.	E 1.99:	DE95017441	MF-1401
3	20:29344	OSTI; NTIS; GPO Dep.	E 1.99:	DE95017440	MF-241
4	20:29245	*See* DOE/CE/15594–T7			
5	20:29194	OSTI; NTIS; GPO Dep.	E 1.99:	DE95017439	MF-1403
CONF-9508122–		(24. international cosmic rays conference (ICRC); Rome (Italy); 28 Aug - 8 sep 1995)			
1	20:30889	*See* LA-UR–95-1475			
CONF-9508133–		(Coal liquefaction and gas conversion contractor review meeting; Pittsburgh, PA (United States); 29-31 Aug 1995)			
6	20:28636	*See* SAND–95-2181C			
7	20:28635	*See* SAND–95-1989C			
CONF-9508134–		(International symposium on phase transformations during thermal/mechanical processing of steel; Vancouver (Canada); 20-23 Aug 1995)			
2	20:29997	OSTI; NTIS; GPO Dep.	E 1.99:	DE95014255	MF-404; MF-405
CONF-9508147–		(ATM Forum Technical Committee meeting; Toronto (Canada); 6 Aug 1995)			
2-Rev.	20:31409	*See* SAND–95-0666C-Rev.			
CONF-9508148–		(Biomass fuels symposium; Chicago, IL (United States); 20-26 Aug 1995)			
1	20:29313	*See* SAND–95-8634C			

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CONF-9508153–		(Applications of time-frequency and time-scale methods; Coventry (United Kingdom); 30-31 Aug 1995)			
1	20:30892	*See* LA-UR–95-2446			
CONF-9508154–		(NATO workshop on super intense laser physics; Moscow (Russian Federation); 4-9 Aug 1995)			
1	20:31105	*See* LA-UR–95-2694			
CONF-9508155–		(17. international symposium on lepton-photon interactions; Beijing (China); 10-15 Aug 1995)			
1	20:30999	*See* FNAL/C–95/201-E			
9	20:31002	*See* FNAL/C–222-E			
10	20:31004	*See* FNAL/C–233-E			
11	20:31003	*See* FNAL/C–229-E			
12	20:30997	*See* FNAL–C-95/165-E			
13	20:30509	*See* FNAL/C–95/239-E			
14	20:31001	*See* FNAL/C–95/249-E			
CONF-9508156–		(Free electron laser conference; New York, NY (United States); 21-25 Aug 1995)			
2	20:30495	*See* LBL–37630			
CONF-9508160–		(24. ICR conference; Rome (Italy); 28 Aug - 8 sep 1995)			
1	20:30890	*See* LA-UR–95-1634			
CONF-9508161–		(NEMA energency management information technology conference; Berryville, VA (United States); 22-24 Aug 1995)			
1	20:30682	*See* UCRL-JC–121765			
CONF-9508162–		(Fillile material cut-off treaty non-routine inspection workshop; Washington, DC (United States); 29 Aug 1995)			
1	20:29981	*See* LA-UR–95-3095			
CONF-9508163–		(Microscopy Socity of America annual meeting; Kansas City, MO (United States); 14-18 Aug 1995)			
1	20:30084	*See* UCRL-JC–121433			
CONF-9508164–		(Plasma physics and technology conference; La Jolla, CA (United States); 8-18 Aug 1995)			
1	20:31280	*See* UCRL-JC–121585			
2	20:31282	*See* UCRL-JC–121624			
CONF-9508165–		(Joint statistical meetings; Orlando, FL (United States); 13-17 Aug 1995)			
2	20:31374	*See* SAND–95-2245C			
3	20:31390	*See* UCRL-JC–121819			
CONF-9508166–		(6. international conference on hopping and related phenomena; Jerusalem (Israel); 27-30 Aug 1995)			
1	20:31114	*See* BNL–62195			
2	20:31103	*See* SAND–95-1976C			
CONF-9508167–		(Tools USA; Santa Barbara, CA (United States); 2 Aug 1995)			
1	20:31387	*See* UCRL-JC–121616			
CONF-9508168–		(NATO advanced research workshop on pulsed metal vapor lasers; St. Andrews (United Kingdom); 7-11 Aug 1995)			
1	20:30395	*See* UCRL-JC–121626			
2	20:30083	*See* UCRL-JC–120702			
CONF-9508169–		(Energy Facilities Contractors Operating Group, Prioritization Working Group & Prioritization Methodology Users Group prioritization methodology workshop; Idaho Falls, ID (United States); 22-23 Aug 1995)			
1	20:31309	*See* SAND–95-2256C			
2	20:29842	*See* LA-UR–95-2677			
CONF-9508170–		(EPA workshop on next generation environmental models computational methods; Bay City, MI (United States); 7-9 Aug 1995)			
1	20:30760	*See* UCRL-JC–121019			
CONF-9508171–		(The present status of the quantum theory of light: a symposium to honor Jean-Piere Vigier; Toronto (Canada); 27-30 Aug 1995)			
1	20:30958	*See* UCRL-JC–121831			

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CONF-9508172–		(1. symposium on the hydrogeology of Washington state; Olympia, WA (United States); 28-30 Aug 1995)			
1	20:30763	*See* WHC-SA–2925-FP			
CONF-9508176–		(10. international congress of radiation research; Wurzburg (Germany); 27 Aug - 1 sep 1995)			
1	20:30821	OSTI; NTIS; INIS; GPO Dep.	E 1.99:	DE96000325	MF-600
2	20:30822	OSTI; NTIS; INIS; GPO Dep.	E 1.99:	DE96000326	MF-600
CONF-9508177–		(5. European conference on cognitive science approaches to process control; Helsinki (Finland); 30 Aug - 1 sep 1995)			
1	20:29521	*See* BNL-NUREG–62207			
CONF-9508178–		(Russia Federation/United States technical exchange on the non-reactor nuclear safety and waste management; Los Alamos, NM (United States); 14-17 Aug 1995)			
1	20:30657	*See* INEL–95/00444			
CONF-950828–		(National heat transfer conference; Portland, OR (United States); 5-9 Aug 1995)			
19	20:29098	*See* LBL–36739			
21	20:29114	*See* SAND–95-2258C			
22	20:28970	*See* SAND–95-2244C			
CONF-950840–		(International conference on applications of diamond films and related materials; Gaithersburg, MD (United States); 21-24 Aug 1995)			
3	20:29996	OSTI; NTIS; GPO Dep.	E 1.99:	DE95014263	MF-404
4	20:30154	*See* BNL–61479			
CONF-950846–		(American Physical Society biennial conference on shock compression of condensed matter; Seattle, WA (United States); 13-18 Aug 1995)			
8	20:30257	*See* LA-UR–95-2369			
9	20:31121	*See* LA-UR–95-2628			
12	20:30550	*See* SAND–95-1884C			
16	20:30585	*See* LA-UR–95-2491			
28	20:30586	*See* LA-UR–95-2764			
39	20:30913	*See* UCRL-JC–121517			
42	20:30596	*See* UCRL-JC–120138			
43	20:30599	*See* UCRL-JC–121439			
44	20:30594	*See* UCRL-JC–11737-R1			
45	20:30354	*See* UCRL-JC–121878			
46	20:30140	*See* SAND–95-0838C			
47	20:30139	*See* SAND–95-0782C			
48	20:30038	*See* LA-UR–95-2826			
49	20:30588	*See* LA-UR–95-2875			
50	20:31180	*See* LA-UR–95-2819			
52	20:30598	*See* UCRL-JC–120140			
53	20:30597	*See* UCRL-JC–120139			
54	20:30566	*See* UCRL-JC–121521			
55	20:30565	*See* UCRL-JC–121519			
56	20:30555	*See* UCRL-JC–121520			
57	20:30382	*See* SAND–95-2058C			
58	20:30045	*See* LA-UR–95-3036			
59	20:30589	*See* LA-UR–95-2956			
60	20:30037	*See* LA-UR–95-2746			
61	20:30085	*See* UCRL-JC–121758			
62	20:30040	*See* LA-UR–95-2884			
63	20:30600	*See* UCRL-JC–121891			
CONF-950848–		(International workshop on diagnostics for ITER; Varenna (Italy); 28 Aug - 1 sep 1995)			
1	20:31184	*See* LA-UR–95-2993			
2	20:31182	*See* LA-UR–95-2930			
CONF-950853–		(ASME/JSME annual summer meeting of the Fluids Engineering conference; Hilton Head, SC (United States); 13-17 Aug 1995)			
7	20:31336	*See* INEL–94/00081			
CONF-950856–		(4. international conference on metallurgical and materials applications of shock-wave and high-strain-rate phenomena; El Paso, TX (United States); 6-10 Aug 1995)			
1	20:30351	*See* SAND–95-0518C			

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4	20:30042	*See* LA-UR–95-2920			
5	20:30143	*See* SAND–95-1969C			
CONF-950857–		(Society of Automotive Engineers future transportation technology conference and exposition; Costa Mesa, CA (United States); 7-10 Aug 1995)			
4	20:29974	*See* UCRL-JC–120325			
CONF-950859–		(11. international conference on vacuum ultraviolet radiation physics; Tokyo (Japan); 27 Aug - 1 sep 1995)			
1	20:30472	*See* LBL–37657			
2	20:30056	*See* LBL–37640			
CONF-950868–		(Environmental remediation conference: committed to results; Denver, CO (United States); 13-18 Aug 1995)			
3	20:28984	*See* UCRL-JC–120389			
10	20:29097	*See* LA-UR–95-2465			
12	20:28789	*See* ANL/EA/CP–86245			
14	20:30716	*See* KCP–613-5602			
15	20:29089	*See* FEMP/SUB–095			
16	20:29088	*See* FEMP–2362B			
17	20:29090	*See* FEMP/SUB–096			
18	20:29117	*See* UCRL-JC–120614			
19	20:30759	*See* UCRL-JC–120613			
20	20:30738	*See* LBL–37554			
CONF-950874–		(7. international conference on II-VI compounds and devices; Edinburgh (United Kingdom); 13-18 Aug 1995)			
2	20:30173	*See* LBL–37586			
CONF-950876–		(19. annual symposium of the Nuclear Information Records Management Association; Washington, DC (United States); 27-30 Aug 1995)			
2	20:31412	*See* WHC-SA–2931-FP			
CONF-950877–		(3. American Society for Mechanical Engineers biennial mixed waste symposium; Baltimore, MD (United States); 7-11 Aug 1995)			
14	20:28788	*See* ANL/CMT/CP–84846			
17	20:28983	*See* UCRL-JC–120141			
18	20:28998	*See* WSRC-MS–95-0184			
19	20:28804	*See* BNL–62204			
CONF-950894–		(International symposium on advanced ceramics for structural and tribological applications; Vancouver (Canada); 19-23 Aug 1995)			
2	20:30112	*See* IS-M–829			
3	20:30111	*See* IS-M–828			
CONF-950908–		(2. international conference on heat resistant materials; Gatlinburg, TN (United States); 11-14 Sep 1995)			
4	20:28999	*See* WSRC-MS–95-0192			
CONF-9509100–		(5. international conference on nuclear criticality safety; Albuquerque, NM (United States); 17-22 Sep 1995)			
19	20:30294	*See* LA-UR–95-2127			
26	20:29499	*See* LA-UR–95-1987			
27	20:29500	*See* LA-UR–95-1988			
28	20:29498	*See* LA-UR–95-1886			
29	20:28774	*See* SAND–95-1990C			
30	20:30319	*See* UCRL-JC–120350			
CONF-9509107–		(3. European symposium on radiations and their effects on components and systems; Arcachon (France); 18-22 Sep 1995)			
1	20:30372	*See* SAND–95-0514C			
2	20:30381	*See* SAND–95-2056C			
CONF-9509125–		(6. international conference on ion sources; Whistler (Canada); 10-16 Sep 1995)			
1	20:30455	*See* LA-UR–95-3091			
2	20:30457	*See* LA-UR–95-3166			
3	20:30442	*See* BNL–61797			

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CONF-950914–		(American Nuclear Society international topical conference on the safety of operating reactors; Seattle, WA (United States); 17-23 Sep 1995)			
4	20:30587	*See* LA-UR–95-2818			
7	20:29581	*See* INEL–95/00381			
CONF-9509141–		(11. interdisciplinary laser science conference: annual meeting of the American Physical Society's Laser Science Topical Group; OSA fall conference; Portland, OR (United States); 10-15 Sep 1995)			
1	20:30373	*See* SAND–95-1059C			
CONF-9509149–		(International symposium on heavy ion inertial fusion; Princeton, NJ (United States); 6-9 Sep 1995)			
1	20:31279	*See* UCRL-JC–121456			
2	20:31276	*See* UCRL-JC–121281			
CONF-9509159–		(8. international conference on parallel and distributed computing systems; Orlando, FL (United States); 20-23 Sep 1995)			
1	20:31389	*See* UCRL-JC–121813			
CONF-9509162–		(Global '95; Versailles (France); 11 Sep 1995)			
6	20:30721	*See* LA-UR–95-1828			
CONF-950917–		(5. international conference on radioactive waste management and environmental remediation; Berlin (Germany); 3-9 Sep 1995)			
14	20:28838	*See* INEL–95/00137			
CONF-9509173–		(International conference on microbial enhanced oil recovery and related biotechnology for solving environment problems; Dallas, TX (United States); 11-14 Sep 1995)			
1	20:28705	*See* BNL–61486			
2	20:28704	*See* BNL–61485			
CONF-9509182–		(1995 National thermal spray conference; Houston, TX (United States); 11-15 Sep 1995)			
5	20:30343	*See* SAND–95-0009C			
CONF-9509187–		(Workshop on photovoltaic performance and reliability; Golden, CO (United States); 7-8 Sep 1995)			
1	20:29401	*See* SAND–95-2078C			
CONF-9509206–		(Finishing '95 conference and exposition; Cincinnati, OH (United States); 19-21 Sep 1995)			
1	20:29948	*See* SAND–95-1143C			
CONF-9509207–		(17. annual international conference of the Electrical & Electronics Engineers Engineering (IEEE) in Medicine & Biology Society (EMBS) and Canadian Medical & Biological Engineering Society (CMBES); Montreal (Canada); 20-23 Sep 1995)			
1	20:30812	*See* UCRL-JC–121246			
CONF-9509209–		(International conference on strongly correlated electron systems; Goa (India); 27-30 Sep 1995)			
1	20:30116	*See* LA-UR–95-2705			
2	20:31122	*See* LA-UR–95-2834			
3	20:30039	*See* LA-UR–95-2833			
CONF-950921–		(16. international conference on amorphous semiconductors; Kobe (Japan); 4-8 Sep 1995)			
8	20:30854	*See* UCRL-JC–121747			
CONF-9509210–		(Appliance manufactures conference and expo; Nashville, TN (United States); 26-27 Sep 1995)			
1	20:29950	*See* SAND–95-8688C			
CONF-9509211–		(17. annual seismic research symposium on monitoring a comprehensive test ban treaty; Scottsdale, AZ (United States); 11-15 Sep 1995)			
1	20:29986	*See* LA-UR–95-2702			
2	20:29985	*See* LA-UR–95-2698			

Report Number	Abstract Number	Source of Availability	GPO Dep.	Order Number	Distribution Category
CONF-9509212–		(Cigre study committee 14 colloquim; Montreal (Canada); 18-19 Sep 1995)			
1	20:29783	OSTI; NTIS; GPO Dep.	E 1.99:	DE95017388	MF-1371
CONF-9509214–		(27. international Society for the Advancement of Materials and Process Engineering (SAMPE) technical conference; Albuquerque, NM (United States); 10-12 Sep 1995)			
1	20:30142	*See* SAND–95-1751C			
CONF-9509218–		(2. International Energy Agency workshop on beryllium technology for fusion; Jackson, WY (United States); 6-8 Sep 1995)			
1	20:30046	*See* LA-UR–95-3046			
2	20:30047	*See* LA-UR–95-3057			
CONF-9509220–		(Workshop on physical protection; Moscow (Russian Federation); 11-14 Sep 1995)			
2	20:29142	*See* SAND–95-2012C			
CONF-9509221–		(Aerospace industries hazardous materials management; Cincinnati, OH (United States); 6 Sep 1995)			
1	20:29841	*See* KCP–613-5658			
CONF-9509222–		(Strongly coupled plasmas conference; Binz (Germany); 11-15 Sep 1995)			
1	20:30900	*See* LA-UR–95-3092			
CONF-9509223–		(UNESCO symposium on science and culture: common path for the future; Tokyo (Japan); 10-15 Sep 1995)			
1	20:30862	*See* LBL–37315			
CONF-9509224–		(Joint meeting of Energy Science Coordinating Committee; Newport News, VA (United States); 28-29 Sep 1995)			
1-Draft	20:31410	*See* SAND–95-2147C-Draft			
CONF-9509225–		(Chemistry for protection of the environment; Lublin (Poland); 18-22 Sep 1995)			
1	20:29846	*See* UCRL-JC–122110			
CONF-9509226–		(15. Association for the International Advancement of High Pressure & Technology international conference; Warsaw (Poland); 11-15 Sep 1995)			
1	20:30601	*See* UCRL-JC–122096			
2	20:30051	*See* LA-UR–95-3145			
3	20:31123	*See* UCRL-JC–122170			
4	20:30044	*See* LA-UR–95-2992			
CONF-9509227–		(MicroBunches workshop; Upton, NY (United States); 28-30 Sep 1995)			
1	20:30456	*See* LA-UR–95-3102			
CONF-9509229–		(4. annual conference on fuzzy theory and technology; Wrightsville Beach, NC (United States); 28 Sep - 1 oct 1995)			
1	20:29000	*See* WSRC-MS–95-0353			
CONF-950923–		(5. international conference on facility-safeguards interface; Jackson Hole, WY (United States); 24-30 Sep 1995)			
3	20:28863	*See* LA-UR–95-3103			
4	20:29143	*See* SAND–95-2125C			
5	20:29144	*See* SAND–95-2135C			
6	20:29146	*See* SAND–95-2145C			
7	20:29145	*See* SAND–95-2136C			
8	20:30516	*See* LA-UR–95-3297			
9	20:31352	*See* LA-UR–95-3222			
11	20:30204	*See* LA-UR–95-3380			
CONF-9509230–		(7. international conference on heavy ion accelerator technology; Canberra (Australia); 18-22 Sep 1995)			
1	20:30445	*See* DOE/ER/40537–51			
2	20:30284	*See* DOE/ER/40537–50			
CONF-9509231–		(European T3D workshop; Lausanne (Switzerland); 7 Sep 1995)			
1	20:31351	*See* LA-UR–95-2971			

Report Number	Abstract Number	Source of Availability	GPO Dep.	Order Number	Distribution Category
CONF-9509232–		(Cray user group meeting; Fairbanks, AK (United States); 25-29 Sep 1995)			
1	20:31372	*See* SAND–95-2134C			
2	20:31373	*See* SAND–95-2195C			
CONF-9509233–		(California Polytechnic State University senior engineering class, ME428 industrial participation problem; San Luis Obispo, CA (United States); 21 Sep 1995)			
1	20:28987	*See* UCRL-JC–121685			
CONF-9509234–		(IAEA research/improvement of measurements, theoretical computations and evaluations of neutron-induced helium production cross sections; Sendai (Japan); 25-29 Sep 1995)			
1	20:31069	*See* LA-UR–95-3329			
CONF-9509235–		(7. international school on neutron physics; Dubna (Russian Federation); 3-22 Sep 1995)			
1	20:31115	*See* BNL–62213			
CONF-950954–		(17. annual electrical overstress/electrostatic discharge symposium; Phoenix, AZ (United States); 11-14 Sep 1995)			
1	20:29987	*See* SAND–95-183OC			
2	20:30618	*See* SAND–95-1831C			
4	20:29989	*See* UCRL-JC–121749			
CONF-950961–		(7. international conference on fusion reactor materials; Obninsk (Russian Federation); 25-29 Sep 1995)			
1	20:31236	*See* SAND–95-0804C			
CONF-950963–		(8. international conference on coal science; Oviedo (Spain); 10-15 Sep 1995)			
2	20:28656	*See* IS-M–83(			
CONF-950976–		(20. annual symposium of the Uranium Institute; London (United Kingdom); 6-8 Sep 1995)			
1	20:28988	*See* UCRL-JC–121922			
CONF-950985–		(14. Institute of Electrical and Electronics Engineers (IEEE) symposium on mass storage systems; Monterey, CA (United States); 11-14 Sep 1995)			
5	20:31411	*See* UCRL-JC–20441			
4-Rev.1	20:31384	*See* UCRL-JC–119772-Rev.1			
CONF-951006–		(Winter meeting of the American Nuclear Society; San Francisco, CA (United States); 29 Oct - 1 nov 1995)			
20	20:29501	*See* LA-UR–95-2069			
21	20:31068	*See* LA-UR–95-2067			
23	20:29006	*See* WSRC-TR–95-0502			
CONF-951007–		(188. meeting of the Electrochemical Society; Chicago, IL (United States); 8-13 Oct 1995)			
3	20:30145	*See* SAND–95-2102C			
4	20:30144	*See* SAND–95-2101C			
5	20:30141	*See* SAND–95-0949C			
CONF-951010–		(International joint power generation conference and exposition; Minneapolis, MN (United States); 8-12 Oct 1995)			
2	20:30348	*See* WSRC-MS–95-0384			
CONF-9510141–		(Institute for Electrical and Electronics Engineers visualization '95; Atlanta, GA (United States); 30 Oct - 3 nov 1995)			
3	20:30345	*See* UCRL-JC–120492			
CONF-9510156–		(23. water reactor safety information meeting; Bethesda, MD (United States); 23-25 Oct 1995)			
	20:29771	*See* NUREG/CP–0148			
CONF-9510189–		(SPIE conference on photonic sensors and controls for commercial applications (Photonics East); Philadelphia, PA (United States); 22-26 Oct 1995)			
1	20:31386	*See* UCRL-JC–121510			
2	20:30392	*See* UCRL-JC–120640			

Report Number	Abstract Number	Source of Availability	GPO Dep.	Order Number	Distribution Category
CONF-9510190--		(28. international symposium on microelectronics: showcasing the stars of microelectronics and 1. international symposium on ball grid array; Los Angeles, CA (United States); 22-26 Oct 1995)			
1	20:30190	*See* UCRL-JC-121193			
CONF-9510193--		(LEOS '95: Institute of Electrical and Electronics Engineers Lasers and Electro-Optics Society annual meeting; San Francisco, CA (United States); 30 Oct - 2 nov 1995)			
3	20:30323	*See* UCRL-JC-121130			
4	20:31202	*See* UCRL-JC-121589			
CONF-9510195--		(66. shock and vibration symposium; Biloxi, MS (United States); 31 Oct - 3 nov 1995)			
1	20:31371	*See* SAND-95-1901C			
3	20:31369	*See* SAND-95-1094C			
4	20:30352	*See* SAND-95-2271C			
CONF-9510196--		(1995 Society of Photo-Optical Instrumentation Engineers (SPIE) meeting; Austin, TX (United States); 23-24 Oct 1995)			
1	20:30377	*See* SAND-95-1885C			
CONF-9510197--		(Institute of Electrical and Electronics Engineers international conference on systems, man and cybernetics; Vancouver (Canada); 22-25 Oct 1995)			
1	20:30326	*See* UCRL-JC-121501			
CONF-9510199--		(Symposium on three-dimensional electromagnetics; Ridgefield, CT (United States); 4-6 Oct 1995)			
1	20:30558	*See* SAND-95-0264C			
CONF-9510202--		(Oceans '95; San Diego, CA (United States); 9-12 Oct 1995)			
1	20:30640	*See* BNL-62137			
2	20:30578	*See* UCRL-JC-119497			
3	20:30579	*See* UCRL-JC-119498			
CONF-9510203--		(IEEE/Industrial Application Society conference; Orlando, FL (United States); 8-12 Oct 1995)			
4	20:29784	OSTI; NTIS; GPO Dep.	E 1.99:	DE95017452	MF-1370
CONF-9510204--		(Micro-integrated smart materials and structures conference (MISMSC); Williamsburg, VA (United States); 11-12 Oct 1995)			
1	20:30378	*See* SAND-95-1892C			
CONF-9510207--		(1. international symposium on proton conducting membrane fuel cells; Chicago, IL (United States); 8-13 Oct 1995)			
5	20:29892	*See* LA-UR-95-2484			
CONF-9510212--		(13. International collaboration on advanced neutron sources; Villigen (Switzerland); 11-14 Oct 1995)			
1	20:31128	*See* LA-UR-95-2937			
CONF-9510217--		(Cloud impacts on DOD operations and systems; Boston, MA (United States); 24-26 Oct 1995)			
1	20:30670	*See* SAND-95-2062C			
CONF-9510218--		(Optical Society of America adaptive optics conference; Garching (Germany); 2-6 Oct 1995)			
1	20:30912	*See* UCRL-JC-121119			
CONF-9510219--		(46. international astronautical congress; Oslo (Norway); 2-6 Oct 1995)			
1	20:28818	*See* DOE/MC/30361-95/C0498			
CONF-9510220--		(7. workshop on RF superconductivity; Paris (France); 17-20 Oct 1995)			
1	20:30454	*See* LA-UR-95-3061			
CONF-9510221--		(ONDCP international technology symposium; Nashua, NH (United States); 24-27 Oct 1995)			
1	20:30198	*See* BNL-62155			

Report Number	Abstract Number	Source of Availability	GPO Dep.	Order Number	Distribution Category
CONF-951033–		(27. international technical conference of the Society for the Advancement of Material and Process Engineering (SAMPE): diversity into the next century; Albuquerque, NM (United States); 9-12 Oct 1995)			
8	20:31368	*See* SAND–95-0471C			
9	20:30191	*See* UCRL-JC–121235			
15	20:29946	*See* SAND–95-0958C			
21	20:30192	*See* UCRL-JC–121620			
CONF-951037–		(Annual meeting of the Geothermal Resources Council; Reno, NV (United States); 8-11 Oct 1995)			
3	20:29413	*See* UCRL-JC–121502			
CONF-951073–		(IEEE nuclear science symposium and medical imaging conference; San Francisco, CA (United States); 21-28 Oct 1995)			
7	20:30535	*See* UCRL-JC–118903			
CONF-951092–		(Human Factors and Ergonomics Society meeting; San Diego, CA (United States); 9-13 Oct 1995)			
3	20:29096	*See* LA-UR–95-2084			
CONF-951101–		(40. conference on magnetism and magnetic materials; Philadelphia, PA (United States); 6-9 Nov 1995)			
2	20:30043	*See* LA-UR–95-2954			
3	20:30041	*See* LA-UR–95-2913			
4	20:30117	*See* LA-UR–95-3027			
CONF-9511106–		(IEEE MILCOM 95: military communications; San Diego, CA (United States); 5-8 Nov 1995)			
1	20:30376	*See* SAND–95-1522C			
2	20:31388	*See* UCRL-JC–121635			
CONF-9511120–		(Symposium on high strain rate effects on polymers metal and ceramic matrix composites and other advanced materials; San Francisco, CA (United States); 14 Nov 1995)			
1	20:30036	*See* LA-UR–95-2590			
CONF-9511121–		(ANNIE '95: artificial neural networks in engineering; St. Louis, MO (United States); 12-15 Nov 1995)			
1	20:29941	*See* LA-UR–95-2720			
CONF-9511122–		(7. U.S.-Japan seminar on dielectric and piezoelectric ceramics; Tsukuba (Japan); 15-17 Nov 1995)			
1	20:30183	*See* SAND–95-1958C			
CONF-9511123–		(Neural information processing systems; Denver, CO (United States); Nov 1995)			
1	20:31348	*See* LA-UR–95-1823			
CONF-9511126–		(14. digital avionics systems conference; Boston, MA (United States); 5-9 Nov 1995)			
1	20:30328	*See* UCRL-JC–121657			
CONF-9511128–		(DOE natural phenomena hazards mitigation symposium; Denver, CO (United States); 13-14 Nov 1995)			
1	20:29025	*See* FEMP/SUB–102			
2	20:29578	*See* BNL–61588			
3	20:29115	*See* SAND–95-2267C			
4	20:30280	*See* BNL–62219			
CONF-9511129–		(Forum on advances in numerical modeling of free surface and interface fluid dynamics; San Francisco, CA (United States); 12 Nov 1995)			
1	20:30346	*See* UCRL-JC–121781			
CONF-9511130–		(Frontiers '95; San Luis Obispo, CA (United States); Nov 1995)			
1	20:28985	*See* UCRL-JC–120547			
CONF-9511131–		(7. international symposium on measurement and modeling of environmental flows; San Francisco, CA (United States); 12-17 Nov 1995)			
1	20:30681	*See* UCRL-JC–121506			

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CONF-9511132–		(3. international symposium on pyrotechnics and explosives; Beijing (China); 6-9 Nov 1995)			
1	20:30590	*See* SAND–94-3060C			
CONF-9511133–		(Bioassay conference; Boston, MA (United States); 12-16 Nov 1995)			
1	20:30228	*See* WSRC-MS–95-0376			
CONF-951135–		(International mechanical engineering congress and exhibition - winter annual meeting of the American Society of Mechanical Engineers; San Francisco, CA (United States); 12-17 Nov 1995)			
11	20:29949	*See* SAND–95-1547C			
13	20:30315	*See* SAND–95-1635C			
17	20:30344	*See* SAND–95-1992C			
18	20:30297	*See* LA-UR–95-2844			
19	20:30078	*See* UCRL-JC–105760			
20	20:29913	*See* LBL–37159			
CONF-951156–		(21. international symposium for testing and failure analysis; Santa Clara, CA (United States); 5-10 Nov 1995)			
3	20:30379	*See* SAND–95-1937C			
CONF-951161–		(International symposium on energy environment economics; Melbourne (Australia); 20-24 Nov 1995)			
1	20:29980	*See* UCRL-JC–121355			
CONF-951176–		(17. New Zealand geothermal workshop: human resources in geothermal development; Auckland (New Zealand); 8-10 Nov 1995)			
1	20:29412	*See* LBL–37611			
CONF-951191–		(Conference on health consequences of the Chernobyl and other radiological accidents; Geneva (Switzerland); 20-23 Nov 1995)			
11	20:30835	*See* UCRL-JC–122072			
CONF-951203–		(11. international conference on packaging and transportation of radioactive materials; Las Vegas, NV (United States); 3-8 Dec 1995)			
1	20:30312	*See* SAND–94-2268C			
2	20:30279	*See* ANL/ET/CP–86568			
CONF-951205–		(International chemical congress of Pacific Basin Societies; Honolulu, HI (United States); 17-22 Dec 1995)			
1	20:30229	OSTI; NTIS; GPO Dep.	E 1.99:	DE95013969	MF-401
CONF-951206–		(34. IEEE conference on decision and control; New Orleans, LA (United States); 13-15 Dec 1995)			
1	20:29975	*See* LA-UR–95-855			
CONF-951207–		(ACM/IEEE-CS supercomputing conference; San Diego, CA (United States); 4-8 Dec 1995)			
1	20:31342	*See* LA-UR–95-906			
2	20:31345	*See* LA-UR–95-1127			
3	20:31344	*See* LA-UR–95-1108			
4	20:31343	*See* LA-UR–95-994			
5	20:31346	*See* LA-UR–95-1296			
CONF-951213–		(41. IEEE international electron devices meeting; Washington, DC (United States); 10-13 Dec 1995)			
1	20:30375	*See* SAND–95-1508C			
CONF-951215–		(6. thermal performances of the exterior envelopes of buildings; Clearwater Beach, FL (United States); 4-8 Dec 1995)			
1	20:29900	OSTI; NTIS; GPO Dep.	E 1.99:	DE95014281	MF-1600
2	20:29901	OSTI; NTIS; GPO Dep.	E 1.99:	DE95016349	MF-1600
CONF-951217–		(IAU colloquium; Sonneberg (Germany); 5-9 Dec 1995)			
1	20:30545	*See* LA-UR–95-273			
CONF-951218–		(Life cycles of energetic materials conference; Del Mar, CA (United States); 11-16 Dec 1995)			
1	20:30584	*See* LA-UR–95-831			

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CONF-951222–		(International conference on carburizing and nitriding with atmospheres; Cleveland, OH (United States); 6-8 Dec 1995)			
1	20:30050	*See* LA-UR–95-3127			
CONF-951229–		(RSC general discussion meeting 102: unimolecular reaction dynamics; Oxford (United Kingdom); 19-21 Dec 1995)			
1	20:31109	*See* LBL–37545			
CONF-951236–		(Computer security applications conference; New Orleans, LA (Luxembourg); 11-15 Dec 1995)			
1	20:31370	*See* SAND–95-1234C			
CONF-951243–		(1. IEEE international Caracas conference on devices circuits and systems; Caracas (Venezuela); 12-14 Dec 1995)			
1	20:30147	*See* SAND–95-2180C			
CONF-951247–		(IEEE semiconductor interface specialists conference; Charleston, SC (United States); 7-9 Dec 1995)			
1	20:30537	*See* SAND–95-1935C			
CONF-951250–		(International semiconductor devices research symposium; Charlottsville, VA (United States); 6-8 Dec 1995)			
1	20:30383	*See* SAND–95-2261C			
CPP–					
93-03	20:30920	*See* DOE/ER/40757–003			
DA-CE–					
028-92059409	20:28752	OSTI; NTIS (US Sales Only)		DE96703557	
DA-CR–					
059-94019412	20:28753	OSTI; NTIS (US Sales Only)		DE96703547	
DD-GU–					
024-92119408	20:28759	OSTI; NTIS (US Sales Only)		DE96703549	
DOE–					
13049-5	20:29422	OSTI; NTIS; GPO Dep.	E 1.99:	DE95016906	MF-1246
DOE-HDBK–					
7502-95-Vol.1	20:31300	OSTI; NTIS; GPO Dep.	E 1.99:	DE95017322	MF-500
7502-95-Vol.2	20:31301	OSTI; NTIS; GPO Dep.	E 1.99:	DE95017323	MF-500
DOE/AL/62350–					
050510.GRNO-Rev.2,Ver.5	20:29071	OSTI; NTIS; INIS; GPO Dep.	E 1.99:	DE96000661	MF-2010
117S	20:30628	OSTI; NTIS; INIS; GPO Dep.	E 1.99:	DE96000658	MF-2010
118S	20:29056	OSTI; NTIS; INIS; GPO Dep.	E 1.99:	DE96000655	MF-2010
121-Rev.1	20:29057	OSTI; NTIS; INIS; GPO Dep.	E 1.99:	DE96000448	MF-2010
122S	20:29058	OSTI; NTIS; INIS; GPO Dep.	E 1.99:	DE96000654	MF-2010
125S	20:30629	OSTI; NTIS; INIS; GPO Dep.	E 1.99:	DE96000659	MF-2010
132-Rev.2	20:30696	OSTI; NTIS; INIS; GPO Dep.	E 1.99:	DE96000653	MF-2010
133-Rev.1-Ver.6	20:29059	OSTI; NTIS; INIS; GPO Dep.	E 1.99:	DE96000691	MF-2010
134-Rev.1	20:29060	OSTI; NTIS; INIS; GPO Dep.	E 1.99:	DE96000238	MF-2070
146S	20:30630	OSTI; NTIS; INIS; GPO Dep.	E 1.99:	DE96000660	MF-2010
147-Rev.1	20:29061	OSTI; NTIS; INIS; GPO Dep.	E 1.99:	DE96000662	MF-2010
175-Rev.1	20:29062	OSTI; NTIS; INIS; GPO Dep.	E 1.99:	DE96000237	MF-2070
179-Rev.1	20:29063	OSTI; NTIS; INIS; GPO Dep.	E 1.99:	DE96000236	MF-2070
194	20:29064	OSTI; NTIS; INIS; GPO Dep.	E 1.99:	DE96000657	MF-2010
195	20:29065	OSTI; NTIS; INIS; GPO Dep.	E 1.99:	DE96000440	MF-2010
196	20:29066	OSTI; NTIS; INIS; GPO Dep.	E 1.99:	DE96000450	MF-2010
197	20:29067	OSTI; NTIS; INIS; GPO Dep.	E 1.99:	DE96000652	MF-2010

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204	20:29068	OSTI; NTIS; INIS; GPO Dep.	E 1.99:	DE96000216	MF-2070
208	20:29069	OSTI; NTIS; INIS; GPO Dep.	E 1.99:	DE96000233	MF-2000
209	20:29070	OSTI; NTIS; INIS; GPO Dep.	E 1.99:	DE96000449	MF-2010
21F-Rev.1	20:29043	OSTI; NTIS; INIS; GPO Dep.	E 1.99:	DE96000224	MF-2010
21F-Rev.1-Attach.	20:29044	OSTI; NTIS; INIS; GPO Dep.	E 1.99:	DE96000228	MF-2010
21F-Rev.1-Attach.3-App.C	20:29045	OSTI; NTIS; INIS; GPO Dep.	E 1.99:	DE96000227	MF-2010
21F-Rev.1-Attach.3-App.A	20:29046	OSTI; NTIS; INIS; GPO Dep.	E 1.99:	DE96000225	MF-2010
21F-Rev.1-Vol.1	20:29047	OSTI; NTIS; INIS; GPO Dep.	E 1.99:	DE96000229	MF-2010
21F-Rev.1-Vol.2	20:29048	OSTI; NTIS; INIS; GPO Dep.	E 1.99:	DE96000230	MF-2010
21F-Rev.1-Vol.3	20:29049	OSTI; NTIS; INIS; GPO Dep.	E 1.99:	DE96000231	MF-2010
21F-Rev.1-Vol.4	20:29050	OSTI; NTIS; INIS; GPO Dep.	E 1.99:	DE96000232	MF-2010
65-Rev.1	20:29051	OSTI; NTIS; INIS; GPO Dep.	E 1.99:	DE96000235	MF-2070
70-Rev.1	20:29052	OSTI; NTIS; INIS; GPO Dep.	E 1.99:	DE96000234	MF-2070
87-Rev.1	20:29053	OSTI; NTIS; INIS; GPO Dep.	E 1.99:	DE96000239	MF-2070; MF-2010
90S	20:29054	OSTI; NTIS; INIS; GPO Dep.	E 1.99:	DE96000240	MF-2010; MF-2070
95-Rev.1	20:30627	OSTI; NTIS; INIS; GPO Dep.	E 1.99:	DE96000656	MF-2010
97-Rev.1	20:29055	OSTI; NTIS; INIS; GPO Dep.	E 1.99:	DE96000447	MF-2010
DOE/AL/98816–					
T2	20:29849	OSTI; NTIS; GPO Dep.	E 1.99:	DE96000307	MF-506
DOE/BC/14831–					
14-Rev.1	20:28677	OSTI; NTIS; GPO Dep.	E 1.99:	DE95000185	PC-122
DOE/BC/14832–					
3	20:28688	OSTI; NTIS; GPO Dep.	E 1.99:	DE95017774	MF-122
DOE/BC/14880–					
14	20:28689	OSTI; NTIS; GPO Dep.	E 1.99:	DE96001045	MF-122
DOE/BC/14884–					
14	20:28690	OSTI; NTIS; GPO Dep.	E 1.99:	DE96000308	MF-122
DOE/BC/14886–					
13	20:28691	OSTI; NTIS; GPO Dep.	E 1.99:	DE96001047	MF-122
DOE/BC/14896–					
8	20:28678	OSTI; NTIS; GPO Dep.	E 1.99:	DE95017585	MF-122
DOE/BC/14899–					
30	20:28692	OSTI; NTIS; GPO Dep.	E 1.99:	DE95017092	MF-122
DOE/BC/14934–					
1	20:28679	OSTI; NTIS; GPO Dep.	E 1.99:	DE95017085	MF-122
DOE/BC/14953–					
11	20:28680	OSTI; NTIS; GPO Dep.	E 1.99:	DE95016922	MF-122
DOE/BC/14954–					
12	20:28693	OSTI; NTIS; GPO Dep.	E 1.99:	DE96001129	MF-122
DOE/BC/14956–					
10	20:28694	OSTI; NTIS; GPO Dep.	E 1.99:	DE95016220	MF-122
11	20:28695	OSTI; NTIS; GPO Dep.	E 1.99:	DE95016218	MF-122
DOE/BC/14957–					
7	20:28696	OSTI; NTIS; GPO Dep.	E 1.99:	DE95000161	PC-122
DOE/BC/14960–					
11	20:28697	OSTI; NTIS; GPO Dep.	E 1.99:	DE96000309	MF-122
DOE/BC/14970–					
4	20:28681	OSTI; NTIS; GPO Dep.	E 1.99:	DE95017773	MF-122
DOE/BC/14971–					
4	20:28760	OSTI; NTIS; GPO Dep.	E 1.99:	DE95017776	MF-131

Report Number	Abstract Number	Source of Availability	GPO Dep.	Order Number	Distribution Category
DOE/BC/14977–					
6	20:28698	OSTI; NTIS; GPO Dep.	E 1.99:	DE95000187	PC-122
DOE/BC/14984–					
5	20:28682	OSTI; NTIS; GPO Dep.	E 1.99:	DE95000186	PC-122
DOE/BC/14989–					
6	20:28683	OSTI; NTIS; GPO Dep.	E 1.99:	DE96001044	MF-122
DOE/BC/14990–					
4	20:28699	OSTI; NTIS; GPO Dep.	E 1.99:	DE95017775	MF-122
DOE/CE/15492–					
T6	20:29998	OSTI; NTIS; GPO Dep.	E 1.99:	DE96000967	MF-1402
DOE/CE/15544–					
T12	20:30697	OSTI; NTIS; GPO Dep.	E 1.99:	DE96000249	MF-1401
DOE/CE/15554–					
T5	20:29925	OSTI; NTIS; GPO Dep.	E 1.99:	DE96000690	MF-1400
DOE/CE/15594–					
T5	20:29244	OSTI; NTIS; GPO Dep.	E 1.99:	DE95017702	MF-1310
T7	20:29245	OSTI; NTIS; GPO Dep.	E 1.99:	DE96000251	MF-1310
T8	20:29246	OSTI; NTIS; GPO Dep.	E 1.99:	DE96000252	MF-1310
DOE/CE/15600–					
T6	20:28700	OSTI; NTIS; GPO Dep.	E 1.99:	DE95016286	MF-123
DOE/CE/23810–					
50	20:30349	OSTI; NTIS; GPO Dep.	E 1.99:	DE96000962	MF-1600
54	20:29926	OSTI; NTIS; GPO Dep.	E 1.99:	DE95017582	MF-1600
58	20:29902	OSTI; NTIS; GPO Dep.	E 1.99:	DE95011238	MF-1600
DOE/CE/34027–					
T14	20:29193	OSTI; NTIS; GPO Dep.	E 1.99:	DE96001046	MF-1350
DOE/CE/50343–					
3	20:29190	OSTI; NTIS; GPO Dep.	E 1.99:	DE96000681	MF-1501
DOE/CH/03073–					
T74	20:31208	OSTI; NTIS; INIS; GPO Dep.	E 1.99:	DE96001109	MF-426
DOE/EA–					
0813	20:31209	OSTI; NTIS; GPO Dep.	E 1.99:	DE95012249	MF-630
0821	20:29827	OSTI; NTIS; INIS; GPO Dep.	E 1.99:	DE96000278	MF-630
0985	20:29828	OSTI; NTIS; INIS; GPO Dep.	E 1.99:	DE96000279	MF-630
1022	20:29829	OSTI; NTIS; INIS; GPO Dep.	E 1.99:	DE96000280	MF-630
1053	20:29830	OSTI; NTIS; INIS; GPO Dep.	E 1.99:	DE96000277	MF-630
1076	20:29831	OSTI; NTIS; INIS; GPO Dep.	E 1.99:	DE96000276	MF-630
1080	20:29446	OSTI; NTIS; GPO Dep.	E 1.99:	DE96000179	MF-630; MF-105
DOE/EE–					
0062	20:29247	OSTI; NTIS; GPO Dep.	E 1.99:	DE95016335	MF-1310
0063	20:29248	OSTI; NTIS; GPO Dep.	E 1.99:	DE95016190	MF-1311
DOE/EE/15623–					
T2	20:29249	OSTI; NTIS; GPO Dep.	E 1.99:	DE96000444	MF-1414
DOE/EH–					
231-006/0991	20:29832	OSTI; NTIS; GPO Dep.	E 1.99:	DE96001049	MF-600
231-011/0592	20:29153	OSTI; NTIS; INIS; GPO Dep.	E 1.99:	DE96001035	MF-600
231-014/0794	20:29833	OSTI; NTIS; GPO Dep.	E 1.99:	DE96000974	MF-600
231-041/0794	20:29834	OSTI; NTIS; GPO Dep.	E 1.99:	DE96000988	MF-600
413052	20:29835	OSTI; NTIS; INIS; GPO Dep.	E 1.99:	DE95017757	MF-630
96000181	20:29927	OSTI; NTIS; GPO Dep.	E 1.99:	DE96000181	MF-602
96000397	20:29836	OSTI; NTIS; INIS; GPO Dep.	E 1.99:	DE96000397	MF-630
DOE/EIA–					
0109(95/09)	20:28708	OSTI; NTIS; GPO; GPO Dep.	E 1.99:	DE96000295	MF-950
0130(95/08)	20:28746	OSTI; NTIS; GPO; GPO Dep.	E 1.99:	DE95017407	MF-950
0130(95/09)	20:28747	OSTI; NTIS; GPO; GPO Dep.	E 1.99:	DE96000811	MF-950
0202(95/3Q)	20:29815	OSTI; NTIS; GPO; GPO Dep.	E 1.99:	DE95016192	MF-950

Report Number	Abstract Number	Source of Availability	GPO Dep.	Order Number	Distribution Category
DOE/EIA–					
0204(95/03)	20:29868	OSTI; NTIS; GPO Dep.	E 1.99:	DE95016193	MF-950
0204(95/04)	20:29878	OSTI; NTIS; GPO; GPO Dep.	E 1.99:	DE96000765	MF-950
0226(95/09)	20:29879	OSTI; NTIS; GPO		DE96000051	MF-950
0321(93)	20:29880	OSTI; NTIS; GPO; GPO Dep.	E 1.99:	DE96001099	MF-950
0380(95/10)	20:28709	OSTI; NTIS; GPO; GPO Dep.	E 1.99:	DE96001051	MF-950
0436(95)	20:29492	OSTI; NTIS; GPO; INIS; GPO Dep.	E 1.99:	DE96000831	MF-950
0520(95/07)	20:28710	OSTI; NTIS; GPO; GPO Dep.	E 1.99:	DE95015682	MF-950
0520(95/09)	20:28711	OSTI; NTIS; GPO; GPO Dep.	E 1.99:	DE96001058	MF-950
0535(94)	20:28712	OSTI; NTIS; GPO; INIS; GPO Dep.	E 1.99:	DE96001071	MF-950
0538(95/96-01)	20:28713	OSTI; NTIS; GPO Dep.	E 1.99:	DE96001133	MF-950
0552(85-91)	20:29928	OSTI; NTIS; GPO; GPO Dep.	E 1.99:	DE96001072	MF-950
0569(95/2Q)	20:29816	OSTI; NTIS; GPO Dep.	E 1.99:	DE96001050	MF-950
0598	20:29837	OSTI; NTIS; GPO; GPO Dep.	E 1.99:	DE96000696	MF-950
0600	20:29874	OSTI; NTIS; GPO; GPO Dep.	E 1.99:	DE96000764	MF-950
95017628	20:31394	OSTI; NTIS; GPO Dep.	E 1.99:	DE95017628	MF-950
DOE/EIA-TR–					
0599	20:29819	OSTI; NTIS; INIS; GPO; GPO Dep.	E 1.99:	DE96000803	MF-950
DOE/EIS–					
0166	20:29791	OSTI; NTIS; INIS; GPO Dep.	E 1.99:	DE95017712	MF-101
0200-D-Summ.	20:28807	OSTI; NTIS; INIS; GPO Dep.	E 1.99:	DE95017564	MF-2000
0210-Exec.Summ.	20:29838	OSTI; NTIS; GPO Dep.	E 1.99:	DE96000273	MF-630
0210-Vol.1	20:28658	OSTI; NTIS; INIS; GPO Dep.	E 1.99:	DE96000274	MF-630
0210-Vol.2	20:28659	OSTI; NTIS; INIS; GPO Dep.	E 1.99:	DE96000275	MF-630
DOE/EM–					
0251	20:30698	OSTI; NTIS; INIS; GPO Dep.	E 1.99:	DE95016176	MF-2010
0256	20:29839	OSTI; NTIS; INIS; GPO Dep.	E 1.99:	DE95017758	MF-2000
0258	20:28775	OSTI; NTIS; GPO Dep.	E 1.99:	DE96000262	MF-2000
DOE/EP/10050–					
T8	20:28748	OSTI; NTIS; INIS; GPO Dep.	E 1.99:	DE95017658	MF-900
DOE/ER–					
0659T	20:29072	OSTI; NTIS; INIS; GPO Dep.	E 1.99:	DE96000157	PC-402
0660T	20:31288	OSTI; NTIS; GPO Dep.	E 1.99:	DE96001128	PC-400
13491-798	20:31101	OSTI; NTIS; GPO Dep.	E 1.99:	DE96001127	MF-411
DOE/ER/03071–					
T1	20:30916	OSTI; NTIS; INIS; GPO Dep.	E 1.99:	DE96000259	MF-414
DOE/ER/03072–					
T11	20:30917	OSTI; NTIS; INIS; GPO Dep.	E 1.99:	DE95017762	MF-414
DOE/ER/12901–					
T1	20:29487	OSTI; NTIS; GPO Dep.	E 1.99:	DE95016968	MF-406; MF-404
DOE/ER/13500–					
T4	20:31112	OSTI; NTIS; GPO Dep.	E 1.99:	DE95017563	MF-411
DOE/ER/13987–					
T1	20:30102	OSTI; NTIS; GPO Dep.	E 1.99:	DE95017767	MF-404
DOE/ER/14047–					
18	20:30788	OSTI; NTIS; GPO Dep.	E 1.99:	DE96000245	MF-408
DOE/ER/14171–					
3	20:30333	OSTI; NTIS; GPO Dep.	E 1.99:	DE95017319	MF-406
DOE/ER/14444–					
1	20:30283	OSTI; NTIS; GPO Dep.	E 1.99:	DE95017586	MF-411
DOE/ER/25188–					
T1	20:31315	OSTI; NTIS; GPO Dep.	E 1.99:	DE95017761	MF-400
DOE/ER/40150–					
284	20:31045	OSTI; NTIS; INIS; GPO Dep.	E 1.99:	DE96000102	MF-414
299	20:30994	OSTI; NTIS; INIS; GPO Dep.	E 1.99:	DE96001410	MF-414
DOE/ER/40160–					
12	20:30995	OSTI; NTIS; INIS; GPO Dep.	E 1.99:	DE95017764	MF-414
DOE/ER/40537–					
50	20:30284	OSTI; NTIS; INIS; GPO Dep.	E 1.99:	DE95017518	MF-413
51	20:30445	OSTI; NTIS; INIS; GPO Dep.	E 1.99:	DE95017519	MF-413
DOE/ER/40757–					
003	20:30920	OSTI; NTIS; INIS; GPO Dep.	E 1.99:	DE96000408	MF-411; MF-405
DOE/ER/40853–					
4	20:30398	OSTI; NTIS; INIS; GPO Dep.	E 1.99:	DE96000443	MF-414
DOE/ER/45522–					
2	20:31116	OSTI; NTIS; GPO Dep.	E 1.99:	DE96000735	MF-410

Report Number	Abstract Number	Source of Availability	GPO Dep.	Order Number	Distribution Category
3	20:30162	OSTI; NTIS; GPO Dep.	E 1.99:	DE96000734	MF-410
DOE/ER/52161–					
T2	20:30024	OSTI; NTIS; INIS; GPO Dep.	E 1.99:	DE96001043	MF-404; MF-423
DOE/ER/54169–					
T1	20:31158	OSTI; NTIS; INIS; GPO Dep.	E 1.99:	DE96000910	MF-426
DOE/ER/60255–					
T1	20:30837	OSTI; NTIS; GPO Dep.	E 1.99:	DE96000297	MF-408
T2	20:30838	OSTI; NTIS; GPO Dep.	E 1.99:	DE96000920	MF-408
DOE/ER/61029–					
19	20:30562	OSTI; NTIS; INIS; GPO Dep.	E 1.99:	DE95017100	MF-402
DOE/ER/61360–					
2	20:30641	OSTI; NTIS; GPO Dep.	E 1.99:	DE96000409	MF-406; MF-412
DOE/ER/61674–					
1	20:30798	OSTI; NTIS; GPO Dep.	E 1.99:	DE96000287	MF-408
DOE/ER/75701–					
2	20:29451	OSTI; NTIS; INIS; GPO Dep.	E 1.99:	DE96000286	MF-405; MF-410
DOE/ER/75707–					
T1	20:31134	OSTI; NTIS; INIS; GPO; GPO Dep.	E 1.99:	DE96000289	MF-411; MF-405
DOE/ER/75755–					
T1	20:29387	OSTI; NTIS; GPO Dep.	E 1.99:	DE95017794	MF-408
DOE/ER/75886–					
T2	20:29522	OSTI; NTIS; INIS; GPO Dep.	E 1.99:	DE95017321	MF-406
DOE/ER/75955–					
T2	20:31299	OSTI; NTIS; GPO Dep.	E 1.99:	DE96000445	MF-400
DOE/ER/76005–					
T1	20:29820	OSTI; NTIS; GPO Dep.	E 1.99:	DE96000299	MF-406
DOE/ER/79198–					
T1	20:29821	OSTI; NTIS; GPO Dep.	E 1.99:	DE96000288	MF-400
DOE/ET/10815–					
T73	20:29885	OSTI; NTIS; GPO Dep.	E 1.99:	DE95016640	MF-112
T74	20:29886	OSTI; NTIS; GPO Dep.	E 1.99:	DE95016688	MF-112
DOE/ET/53088–					
716	20:31133	OSTI; NTIS; INIS; GPO Dep.	E 1.99:	DE96000246	MF-427
717	20:31159	OSTI; NTIS; INIS; GPO Dep.	E 1.99:	DE96000247	MF-427
DOE/EW/50625–					
T25	20:30631	OSTI; NTIS; GPO Dep.	E 1.99:	DE95016555	MF-2000
DOE/FE–					
0340	20:28719	OSTI; NTIS; GPO Dep.	E 1.99:	DE95017557	MF-126
DOE/GO–					
10094-040	20:29903	OSTI; NTIS; GPO Dep.	E 1.99:	DE95000249	PC-920
10095-014	20:30842	OSTI; NTIS; GPO Dep.	E 1.99:	DE95000206	MF-1380
10095-194	20:29904	OSTI; NTIS; GPO Dep.	E 1.99:	DE95009274	MF-1600
10095-197	20:29867	OSTI; NTIS; GPO Dep.	E 1.99:	DE95009282	MF-1600
DOE/ID–					
10430(CT)	20:29378	OSTI; NTIS; GPO Dep.	E 1.99:	DE96001343	MF-1220
10430(MA)	20:29379	OSTI; NTIS; GPO Dep.	E 1.99:	DE96001330	MF-1220
10430(ME)	20:29380	OSTI; NTIS; GPO Dep.	E 1.99:	DE96001324	MF-1220
10430(RI)	20:29381	OSTI; NTIS; GPO Dep.	E 1.99:	DE96001156	MF-1220
10510(94-95)	20:29383	OSTI; NTIS; INIS; GPO; GPO Dep.	E 1.99:	DE96001331	MF-1220
10511	20:28776	OSTI; NTIS; INIS; GPO Dep.	E 1.99:	DE96001332	MF-2000
10513	20:29073	OSTI; NTIS; INIS; GPO Dep.	E 1.99:	DE96001578	MF-2010
10515	20:28808	OSTI; NTIS; INIS; GPO Dep.	E 1.99:	DE96001155	MF-2000
22117	20:30699	OSTI; NTIS; INIS; GPO Dep.	E 1.99:	DE96001159	

DOE/ID–

Report Number	Abstract Number	Source of Availability	GPO Dep.	Order Number	Distribution Category
22118	20:28809	OSTI; NTIS; U.S Geological Survey, Earth Science Information Center, Open-File Reports Section, Box 25286, Mail Stop 517, Federal Center, Denver, CO 80225; GPO Dep.	E 1.99:	DE96001161	
22120	20:30700	OSTI; NTIS; GPO Dep.	E 1.99:	DE96001160	
DOE/IG–					
0379	20:29871	OSTI (Free of Charge)		TI96000178	PC-960
DOE/LLW–					
128	20:28810	OSTI; NTIS; INIS; GPO Dep.	E 1.99:	DE95017655	MF-2010
129-Vol.13	20:28811	OSTI; NTIS; INIS; GPO Dep.	E 1.99:	DE96001323	MF-2000
186	20:28812	OSTI; NTIS; INIS; GPO Dep.	E 1.99:	DE95017654	MF-2010
187	20:28813	OSTI; NTIS; INIS; GPO Dep.	E 1.99:	DE96001326	MF-2000
189	20:28814	OSTI; NTIS; INIS; GPO Dep.	E 1.99:	DE96001576	MF-2000
192	20:28777	OSTI; NTIS; INIS; GPO Dep.	E 1.99:	DE95017651	MF-2020
199	20:28815	OSTI; NTIS; INIS; GPO Dep.	E 1.99:	DE96001577	MF-2000
208	20:28816	OSTI; NTIS; INIS; GPO Dep.	E 1.99:	DE95017656	MF-2020
221	20:28817	OSTI; NTIS; INIS; GPO Dep.	E 1.99:	DE95017657	MF-2000
DOE/MC/24132–					
5002	20:28662	OSTI; NTIS; GPO Dep.	E 1.99:	DE95009738	MF-103
DOE/MC/24257–					
5003	20:28592	OSTI; NTIS; GPO Dep.	E 1.99:	DE96000878	MF-106; MF-111
DOE/MC/25140–					
5005	20:28593	OSTI; NTIS; GPO Dep.	E 1.99:	DE95009740	MF-106
DOE/MC/26042–					
4083	20:29447	OSTI; NTIS; INIS; GPO Dep.	E 1.99:	DE95009729	MF-103
DOE/MC/27205–					
5006	20:28663	OSTI; NTIS; GPO Dep.	E 1.99:	DE96000879	MF-107
DOE/MC/27229–					
5007	20:28664	OSTI; NTIS; GPO Dep.	E 1.99:	DE96000880	MF-103
DOE/MC/27362–					
4089	20:28577	OSTI; NTIS; GPO Dep.	E 1.99:	DE95009736	MF-102
DOE/MC/27363–					
5012	20:29428	OSTI; NTIS; GPO Dep.	E 1.99:	DE95009742	MF-109
DOE/MC/28055–					
95/C0493	20:29887	OSTI; NTIS; GPO Dep.	E 1.99:	DE95015473	MF-110
DOE/MC/30088–					
95/C0474	20:28740	OSTI; NTIS; GPO Dep.	E 1.99:	DE95014562	MF-131
DOE/MC/30246–					
4066	20:29429	OSTI; NTIS; GPO Dep.	E 1.99:	DE95009712	MF-111
DOE/MC/30361–					
4087	20:28819	OSTI; NTIS; INIS; GPO Dep.	E 1.99:	DE95009734	MF-2020
95/C0498	20:28818	OSTI; NTIS; GPO Dep.	E 1.99:	DE95017866	MF-2000
DOE/MC/31114–					
95/C0487	20:28754	OSTI; NTIS; GPO Dep.	E 1.99:	DE95014480	MF-131
DOE/MC/31197–					
95/C0472	20:28701	OSTI; NTIS; GPO Dep.	E 1.99:	DE95014022	MF-132
DOE/MC/31224–					
5021	20:28735	OSTI; NTIS; GPO Dep.	E 1.99:	DE95009751	MF-132
DOE/MT/92002–					
11	20:28717	OSTI; NTIS; GPO Dep.	E 1.99:	DE96001027	MF-122
DOE/MT/92009–					
T2	20:28715	OSTI; NTIS; GPO Dep.	E 1.99:	DE96000937	MF-122
DOE/MT/92017–					
T1	20:28645	OSTI; NTIS; GPO Dep.	E 1.99:	DE96000935	MF-105
T2	20:28646	OSTI; NTIS; GPO Dep.	E 1.99:	DE96000936	MF-105
DOE/MT/92018–					
T1	20:28647	OSTI; NTIS; GPO Dep.	E 1.99:	DE96000934	MF-105
DOE/MT/92019–					
T3	20:28578	OSTI; NTIS; GPO Dep.	E 1.99:	DE96000932	MF-102

Report Number	Abstract Number	Source of Availability	GPO Dep.	Order Number	Distribution Category
T4	20:28579	OSTI; NTIS; GPO Dep.	E 1.99:	DE96000933	MF-102
DOE/MT/94010–					
T1	20:28594	OSTI; NTIS; GPO Dep.	E 1.99:	DE96000918	MF-108
T2	20:28595	OSTI; NTIS; GPO Dep.	E 1.99:	DE96000919	MF-108
DOE/MT/94011–					
T1	20:28761	OSTI; NTIS; GPO Dep.	E 1.99:	DE96000945	MF-131
DOE/MT/94013–					
T1	20:28665	OSTI; NTIS; GPO Dep.	E 1.99:	DE96000940	MF-104
T2	20:28666	OSTI; NTIS; GPO Dep.	E 1.99:	DE96000941	MF-104
DOE/MT/94014–					
T1	20:28751	OSTI; NTIS; GPO Dep.	E 1.99:	DE96000939	MF-122
DOE/NV–					
11432-195	20:30701	OSTI; NTIS; INIS; GPO Dep.	E 1.99:	DE96000768	MF-702
DOE/NV/11432–					
197	20:30642	OSTI; NTIS; INIS; GPO Dep.	E 1.99:	DE96000152	MF-603
DOE/NV/11508–					
01	20:30702	OSTI; NTIS; GPO Dep.	E 1.99:	DE95017517	MF-703
DOE/NV/11630–					
T1	20:30505	OSTI; NTIS; INIS; GPO Dep.	E 1.99:	DE96001130	MF-704
DOE/OR/21400–					
T480	20:30103	OSTI; NTIS; GPO Dep.	E 1.99:	DE96000759	MF-1425
T481	20:30104	OSTI; NTIS; GPO Dep.	E 1.99:	DE96000760	MF-1425
T482	20:31316	OSTI; NTIS; INIS; GPO Dep.	E 1.99:	DE96000762	MF-2060
T483	20:29840	OSTI; NTIS; INIS; GPO Dep.	E 1.99:	DE96000664	MF-2070; MF-2010
T484	20:29905	OSTI; NTIS; GPO Dep.	E 1.99:	DE96000665	MF-1425
T486	20:28667	OSTI; NTIS; GPO Dep.	E 1.99:	DE96000667	MF-103
T487	20:30105	OSTI; NTIS; GPO Dep.	E 1.99:	DE96000668	MF-1425
T488	20:30285	OSTI; NTIS; GPO Dep.	E 1.99:	DE96000669	MF-706
T489	20:30163	OSTI; NTIS; GPO Dep.	E 1.99:	DE96000670	MF-411
T490	20:30106	OSTI; NTIS; GPO Dep.	E 1.99:	DE96000671	MF-1406
T491	20:30230	OSTI; NTIS; GPO Dep.	E 1.99:	DE96000672	MF-401; MF-404
T492	20:29074	OSTI; NTIS; GPO Dep.	E 1.99:	DE96000673	ND-510
T493	20:29929	OSTI; NTIS; GPO Dep.	E 1.99:	DE96000674	MF-1418
T494	20:29388	OSTI; NTIS; GPO Dep.	E 1.99:	DE96000675	MF-1260
T495	20:28820	OSTI; NTIS; INIS; GPO Dep.	E 1.99:	DE96000676	MF-811
T496	20:30506	OSTI; NTIS; INIS; GPO Dep.	E 1.99:	DE96000677	MF-407
T497	20:30164	OSTI; NTIS; GPO Dep.	E 1.99:	DE96000678	MF-1425
T498	20:28821	OSTI; NTIS; INIS; GPO Dep.	E 1.99:	DE96000679	MF-510
T499	20:31160	OSTI; NTIS; GPO Dep.	E 1.99:	DE96000687	MF-406
DOE/ORO–					
2032	20:29075	OSTI; NTIS; INIS; GPO Dep.	E 1.99:	DE96001201	MF-2000
DOE/PC/88819–					
T18	20:28596	OSTI; NTIS; GPO Dep.	E 1.99:	DE95017772	MF-108
T19	20:28597	OSTI; NTIS; GPO Dep.	E 1.99:	DE95017770	MF-108
DOE/PC/89651–					
T22	20:28668	OSTI; NTIS; GPO Dep.	E 1.99:	DE95017742	MF-104
DOE/PC/89652–					
T11	20:28648	OSTI; NTIS; GPO Dep.	E 1.99:	DE95017340	MF-105
DOE/PC/89664–					
T11	20:28580	OSTI; NTIS; GPO Dep.	E 1.99:	DE95017741	MF-102
T12	20:28581	OSTI; NTIS; GPO Dep.	E 1.99:	DE95017740	MF-102
DOE/PC/89766–					
T18	20:28582	OSTI; NTIS; GPO Dep.	E 1.99:	DE96000976	MF-102
DOE/PC/89773–					
T4	20:28637	OSTI; NTIS; GPO Dep.	E 1.99:	DE95017769	MF-108; MF-109

Report Number	Abstract Number	Source of Availability	GPO Dep.	Order Number	Distribution Category
DOE/PC/90048–					
T10	20:28604	OSTI; NTIS; GPO Dep.	E 1.99:	DE96000965	MF-108
T4	20:28598	OSTI; NTIS; GPO Dep.	E 1.99:	DE96000973	MF-108
T5	20:28599	OSTI; NTIS; GPO Dep.	E 1.99:	DE96000972	MF-108
T6	20:28600	OSTI; NTIS; GPO Dep.	E 1.99:	DE96000971	MF-108
T7	20:28601	OSTI; NTIS; GPO Dep.	E 1.99:	DE96000970	MF-108
T8	20:28602	OSTI; NTIS; GPO Dep.	E 1.99:	DE96000969	MF-108
T9	20:28603	OSTI; NTIS; GPO Dep.	E 1.99:	DE96000968	MF-108
DOE/PC/90180–					
T14	20:28661	OSTI; NTIS; GPO Dep.	E 1.99:	DE95017744	MF-117
DOE/PC/90183–					
T16	20:30334	OSTI; NTIS; GPO Dep.	E 1.99:	DE96000930	MF-117
DOE/PC/90291–					
T13	20:28605	OSTI; NTIS; GPO Dep.	E 1.99:	DE95017768	MF-108
DOE/PC/90542–					
T10	20:29442	OSTI; NTIS; GPO Dep.	E 1.99:	DE96000327	MF-105
DOE/PC/90547–					
T19	20:28649	OSTI; NTIS; GPO Dep.	E 1.99:	DE95017754	MF-104
T20	20:29443	OSTI; NTIS; GPO Dep.	E 1.99:	DE95017755	MF-104
DOE/PC/91056–					
T10	20:28607	OSTI; NTIS; GPO Dep.	E 1.99:	DE95017752	MF-108
T9	20:28606	OSTI; NTIS; GPO Dep.	E 1.99:	DE95017751	MF-108
DOE/PC/91154–					
T9	20:29430	OSTI; NTIS; GPO Dep.	E 1.99:	DE95017738	MF-104
DOE/PC/91155–					
T11	20:29431	OSTI; NTIS; GPO Dep.	E 1.99:	DE96000931	MF-104
DOE/PC/91160–					
T6	20:28669	OSTI; NTIS; GPO Dep.	E 1.99:	DE95016268	MF-104
T7	20:28670	OSTI; NTIS; GPO Dep.	E 1.99:	DE95017749	MF-104
DOE/PC/91257–					
T21	20:28608	OSTI; NTIS; GPO Dep.	E 1.99:	DE95017783	MF-102
T23	20:28609	OSTI; NTIS; GPO Dep.	E 1.99:	DE95017785	MF-102
T24	20:28610	OSTI; NTIS; GPO Dep.	E 1.99:	DE95017786	MF-102
T26	20:28611	OSTI; NTIS; GPO Dep.	E 1.99:	DE95017788	MF-102
DOE/PC/91293–					
T5	20:28650	OSTI; NTIS; GPO Dep.	E 1.99:	DE95017760	MF-105
DOE/PC/91300–					
T13	20:28612	OSTI; NTIS; GPO Dep.	E 1.99:	DE96000923	MF-108
T14	20:28613	OSTI; NTIS; GPO Dep.	E 1.99:	DE96000924	MF-108
DOE/PC/91306–					
T2	20:28671	OSTI; NTIS; GPO Dep.	E 1.99:	DE96000963	MF-113
DOE/PC/91307–					
T14	20:28614	OSTI; NTIS; GPO Dep.	E 1.99:	DE95017747	MF-104; MF-113
T15	20:28615	OSTI; NTIS; GPO Dep.	E 1.99:	DE95017748	MF-104; MF-113
DOE/PC/91337–					
T3	20:28651	OSTI; NTIS; GPO Dep.	E 1.99:	DE95017777	MF-105
T4	20:28652	OSTI; NTIS; GPO Dep.	E 1.99:	DE95017778	MF-105
T5	20:28653	OSTI; NTIS; GPO Dep.	E 1.99:	DE95017779	MF-105
T6	20:28654	OSTI; NTIS; GPO Dep.	E 1.99:	DE95017780	MF-105
DOE/PC/91338–					
T9	20:29444	OSTI; NTIS; GPO Dep.	E 1.99:	DE95015520	MF-105
DOE/PC/92106–					
T10	20:30231	OSTI; NTIS; GPO Dep.	E 1.99:	DE96000921	MF-113
DOE/PC/92108–					
T10	20:28616	OSTI; NTIS; GPO Dep.	E 1.99:	DE96000868	MF-108
DOE/PC/92110–					
T9	20:28741	OSTI; NTIS; GPO Dep.	E 1.99:	DE96000928	MF-108; MF-113
DOE/PC/92112–					
T10	20:28742	OSTI; NTIS; GPO Dep.	E 1.99:	DE96000929	MF-113
DOE/PC/92122–					
T10	20:28617	OSTI; NTIS; GPO Dep.	E 1.99:	DE96000926	MF-108; MF-113
DOE/PC/92147–					
10	20:28618	OSTI; NTIS; GPO Dep.	E 1.99:	DE96000904	MF-108
DOE/PC/92152–					
T16	20:30335	OSTI; NTIS; GPO Dep.	E 1.99:	DE96000925	MF-113
DOE/PC/92190–					
T8	20:28672	OSTI; NTIS; GPO Dep.	E 1.99:	DE95017753	MF-104

Report Number	Abstract Number	Source of Availability	GPO Dep.	Order Number	Distribution Category
DOE/PC/92205–					
T7	20:28583	OSTI; NTIS; GPO Dep.	E 1.99:	DE95016280	MF-102
DOE/PC/92208–					
T10	20:28584	OSTI; NTIS; GPO Dep.	E 1.99:	DE95017739	MF-102
DOE/PC/92526–					
T11	20:28585	OSTI; NTIS; GPO Dep.	E 1.99:	DE96000922	MF-102
DOE/PC/92527–					
T10	20:28638	OSTI; NTIS; GPO Dep.	E 1.99:	DE95017750	MF-108
DOE/PC/92544–					
11	20:28639	OSTI; NTIS; GPO Dep.	E 1.99:	DE95016265	MF-113
12	20:28640	OSTI; NTIS; GPO Dep.	E 1.99:	DE96000902	MF-113
DOE/PC/92547–					
9	20:28586	OSTI; NTIS; GPO Dep.	E 1.99:	DE96000903	MF-102
T8	20:28587	OSTI; NTIS; GPO Dep.	E 1.99:	DE95017746	MF-102
DOE/PC/92550–					
10	20:28588	OSTI; NTIS; GPO Dep.	E 1.99:	DE95017756	MF-102
DOE/PC/93054–					
14	20:28641	OSTI; NTIS; GPO Dep.	E 1.99:	DE96000907	MF-108
DOE/PC/93066–					
T1	20:28619	OSTI; NTIS; GPO Dep.	E 1.99:	DE96000911	MF-108
T2	20:28620	OSTI; NTIS; GPO Dep.	E 1.99:	DE96000912	MF-108; MF-113
T3	20:28621	OSTI; NTIS; GPO Dep.	E 1.99:	DE96000913	MF-108; MF-113
T4	20:28622	OSTI; NTIS; GPO Dep.	E 1.99:	DE96000914	MF-108; MF-113
T5	20:28623	OSTI; NTIS; GPO Dep.	E 1.99:	DE96000915	MF-108; MF-113
DOE/PC/93202–					
7	20:28642	OSTI; NTIS; GPO Dep.	E 1.99:	DE96000906	MF-113
DOE/PC/93206–					
7	20:28643	OSTI; NTIS; GPO Dep.	E 1.99:	DE96000905	MF-113
DOE/PC/93222–					
6	20:28655	OSTI; NTIS; GPO Dep.	E 1.99:	DE95017603	MF-113
DOE/PC/94055–					
T2	20:28624	OSTI; NTIS; GPO Dep.	E 1.99:	DE95016281	MF-108
DOE/PC/94065–					
T2	20:28625	OSTI; NTIS; GPO Dep.	E 1.99:	DE95015914	MF-109
DOE/PC/94119–					
T5	20:28673	OSTI; NTIS; GPO Dep.	E 1.99:	DE96000938	MF-113
DOE/PC/94202–					
T3	20:28589	OSTI; NTIS; GPO Dep.	E 1.99:	DE95017745	MF-102
DOE/PC/94207–					
T3	20:28626	OSTI; NTIS; GPO Dep.	E 1.99:	DE95016270	MF-106
DOE/RL–					
89-16-Rev.A	20:29076	OSTI; NTIS; INIS; GPO Dep.	E 1.99:	DE96001202	MF-2030
93-54	20:29077	OSTI; NTIS; INIS; GPO Dep.	E 1.99:	DE95017536	MF-2010
93-64-Rev.3	20:29078	OSTI; NTIS; GPO Dep.	E 1.99:	DE95017352	MF-2010
93-82	20:29079	OSTI; NTIS; INIS; GPO Dep.	E 1.99:	DE96000282	MF-2010
94-100	20:29016	OSTI; NTIS; INIS; GPO Dep.	E 1.99:	DE95017540	MF-2010
94-101	20:29082	OSTI; NTIS; INIS; GPO Dep.	E 1.99:	DE95017539	MF-2010
94-101-Rev.1	20:29017	OSTI; NTIS; INIS; GPO Dep.	E 1.99:	DE95017541	MF-2010
94-102	20:29018	OSTI; NTIS; INIS; GPO Dep.	E 1.99:	DE95017545	MF-2010
94-102-Rev.1	20:29019	OSTI; NTIS; INIS; GPO Dep.	E 1.99:	DE95017501	MF-2010
94-104	20:28823	OSTI; NTIS; INIS; GPO Dep.	E 1.99:	DE96000284	MF-2070
94-113-Rev.1	20:29020	OSTI; NTIS; INIS; GPO Dep.	E 1.99:	DE95017496	MF-2050
94-119	20:29021	OSTI; NTIS; INIS; GPO Dep.	E 1.99:	DE95017512	MF-2010
94-119-Rev.1	20:29083	OSTI; NTIS; INIS; GPO Dep.	E 1.99:	DE96000283	MF-2010

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DOE/RL–					
94-30	20:29013	OSTI; NTIS; INIS; GPO Dep.	E 1.99:	DE95017534	MF-2010
94-48	20:29080	OSTI; NTIS; INIS; GPO Dep.	E 1.99:	DE95017528	MF-2010
94-61-Vol.2	20:29014	OSTI; NTIS; INIS; GPO Dep.	E 1.99:	DE95017537	MF-2070
94-67	20:29081	OSTI; NTIS; INIS; GPO Dep.	E 1.99:	DE95017530	MF-2010
94-96-Rev.1	20:28822	OSTI; NTIS; INIS; GPO Dep.	E 1.99:	DE96001068	MF-2000
94-99	20:29015	OSTI; NTIS; INIS; GPO Dep.	E 1.99:	DE95017538	MF-2010
95-26	20:29022	OSTI; NTIS; INIS; GPO Dep.	E 1.99:	DE95017529	MF-2010
95-30	20:29023	OSTI; NTIS; INIS; GPO Dep.	E 1.99:	DE95017544	MF-2010
95-38	20:28824	OSTI; NTIS; INIS; GPO Dep.	E 1.99:	DE95017514	MF-2010
95-43	20:28778	OSTI; NTIS; INIS; GPO Dep.	E 1.99:	DE96000683	MF-2000
95-46	20:29084	OSTI; NTIS; INIS; GPO Dep.	E 1.99:	DE96000281	MF-2010
95-56-Rev.2	20:29085	OSTI; NTIS; INIS; GPO Dep.	E 1.99:	DE95017499	MF-2000
95-60	20:29024	OSTI; NTIS; INIS; GPO Dep.	E 1.99:	DE95017497	MF-2010
DOE/RW–					
0253-Rev.5	20:28825	OSTI; NTIS; GPO Dep.	E 1.99:	DE96000815	MF-800
0477	20:28826	OSTI; NTIS; INIS; GPO Dep.	E 1.99:	DE96000156	MF-814
DOE/SF–					
19460-91	20:31211	OSTI; NTIS; INIS; GPO Dep.	E 1.99:	DE96000767	MF-712
DOE/SF/17787–					
T18	20:29488	OSTI; NTIS; GPO Dep.	E 1.99:	DE96001033	MF-400
DOE/SF/18852–					
T56	20:29182	OSTI; NTIS; INIS; GPO Dep.	E 1.99:	DE96001142	MF-528
DOE/SR/18445–					
T2	20:28827	OSTI; NTIS; INIS; GPO Dep.	E 1.99:	DE95014297	MF-2000
DUN–					
504	20:29529	OSTI; NTIS; GPO Dep.	E 1.99:	DE95012714	MF-500
EFR-TDD–					
950060	20:30286	OSTI; NTIS; INIS; GPO Dep.	E 1.99:	DE96060012	MF-2050
EGG–					
10617-1230	20:29452	OSTI; NTIS; INIS; GPO Dep.	E 1.99:	DE96001126	
10617-1238	20:30703	OSTI; NTIS; INIS; GPO Dep.	E 1.99:	DE96001110	MF-702
11265-1087	20:30704	OSTI; NTIS; GPO Dep.	E 1.99:	DE96001125	MF-706
11265-1115	20:28718	OSTI; NTIS; INIS; GPO Dep.	E 1.99:	DE96000191	MF-702
11265-1118	20:30632	OSTI; NTIS; INIS; GPO Dep.	E 1.99:	DE96000185	MF-702
11265-1120	20:30107	OSTI; NTIS; GPO Dep.	E 1.99:	DE96000160	MF-701
11265-1122	20:29086	OSTI; NTIS; INIS; GPO Dep.	E 1.99:	DE96000167	MF-708
11265-1124	20:30843	OSTI; NTIS; GPO Dep.	E 1.99:	DE96000158	MF-708
11265-1125	20:30633	OSTI; NTIS; INIS; GPO Dep.	E 1.99:	DE96000159	MF-708
11265-1130	20:31317	OSTI; NTIS; GPO Dep.	E 1.99:	DE96000154	MF-707
11265-1134	20:30705	OSTI; NTIS; GPO Dep.	E 1.99:	DE96000169	MF-708
11265-1135	20:30785	OSTI; NTIS; GPO Dep.	E 1.99:	DE96000168	MF-708
11265-2019	20:30706	OSTI; NTIS; GPO Dep.	E 1.99:	DE96000186	MF-708
11265-2047	20:30707	OSTI; NTIS; GPO Dep.	E 1.99:	DE96000161	MF-702
11265-5019	20:30507	OSTI; NTIS; INIS; GPO Dep.	E 1.99:	DE96000163	MF-706
11265-5031	20:31318	OSTI; NTIS; GPO Dep.	E 1.99:	DE96000190	MF-706
11265-5032	20:30846	OSTI; NTIS; GPO Dep.	E 1.99:	DE96001097	MF-705
11265-5040	20:30295	*See* LA-UR–95-2322			
11265-5045	20:30456	*See* LA-UR–95-3102			
ELFORSK–					
93-2	20:29382	OSTI; NTIS		DE96703693	
94-15	20:29396	OSTI; NTIS		DE96703697	
94-17	20:29384	OSTI; NTIS		DE96703696	
95-4	20:29850	OSTI; NTIS		DE96703690	
95-10(B)	20:29930	OSTI; NTIS		DE96703695	
95-16	20:29876	OSTI; NTIS; INIS		DE96703694	

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EML–					
563	20:30643	OSTI; NTIS; INIS; GPO Dep.	E 1.99:	DE95014918	MF-407
566	20:30644	OSTI; NTIS; INIS; GPO Dep.	E 1.99:	DE95014916	MF-407
EPA–					
600/S-95/012	20:29932	OSTI; NTIS		DE96001532	
600/S-95/013	20:29933	OSTI; NTIS		DE96001533	
600/S-95/016	20:29934	OSTI; NTIS		DE96001535	
600/S-95/018	20:29935	OSTI; NTIS		DE96001536	
600/S-95/022	20:29936	OSTI; NTIS		DE96001537	
600/S-95/023	20:29937	OSTI; NTIS		DE96001538	
600/S-95/030	20:29938	OSTI; NTIS		DE96001539	
600/S-95/031	20:29939	OSTI; NTIS		DE96001540	
600/S-95/032	20:29940	OSTI; NTIS		DE96001541	
904/9-94-002(a)	20:28658	*See* DOE/EIS–0210-Vol.1			
904/9-94-002(b)	20:28659	*See* DOE/EIS–0210-Vol.2			
904/9-94-002(c)	20:29838	*See* DOE/EIS–0210-Exec.Summ.			
EPA/600/S–					
95/008	20:29931	OSTI; NTIS		TI96000724	
ES/WM–					
59	20:29953	OSTI; NTIS; GPO Dep.	E 1.99:	DE95017312	MF-603
ESH-EMS–					
940516	20:29087	OSTI; NTIS; INIS; GPO Dep.	E 1.99:	DE95017503	MF-702
ESTSC–					
000138FUJ5000	20:31319	ESTSC			
000154FUJ5000	20:31320	ESTSC			
000154FUJ5001	20:31321	ESTSC			
000260SPARC00	20:31322	ESTSC			
000324IB38602	20:31323	ESTSC; Lawrence Livermore National Lab			
000324SUN0004	20:31324	ESTSC; Lawrence Livermore National Lab			
000816AL00000	20:31325	ESTSC			
000817AL00000	20:31326	ESTSC			
000829SUN0000	20:31327	ESTSC			
000831SPARC00	20:31328	ESTSC			
000987IBMPC00	20:31329	ESTSC			
001001SPARC00	20:31330	ESTSC			
001037MLTPL00	20:31331	ESTSC			
001051SUN0000	20:31332	ESTSC			
001059IBMPC00	20:31333	RADIATION SHIELDING INFORMATION CENTER			
001060MC68H00	20:31334	ESTSC			
ETDE-DE–					
199	20:30648	OSTI; NTIS (US Sales Only)		DE96706593	
200	20:30649	OSTI; NTIS (US Sales Only)		DE96706583	
201	20:30650	OSTI; NTIS (US Sales Only)		DE96706567	
202	20:30651	OSTI; NTIS (US Sales Only)		DE96706561	
203	20:30358	OSTI; NTIS (US Sales Only)		DE96706596	
204	20:30652	OSTI; NTIS (US Sales Only)		DE96706591	
205	20:30653	OSTI; NTIS (US Sales Only)		DE96706563	
206	20:30654	OSTI; NTIS (US Sales Only)		DE96706562	
207	20:28627	OSTI; NTIS (US Sales Only)		DE96706600	
ETDE/CH-mf–					
95787322	20:29809	OSTI; NTIS		DE95787322	
ETDE/JP-mf–					
96704395	20:29414	OSTI; NTIS; Available from New Energy and Industrial Technology Development Organization, Sunshine 60, 30F 1-1, 3-chome, Higashi-Ikebukuro, Toshima-ku, Tokyo, Japan		DE96704395	
96704396	20:29415	OSTI; NTIS; Available from New Energy and Industrial Technology Development Organization, Sunshine 60, 30F 1-1, 3-chome, Higashi-Ikebukuro, Toshima-ku, Tokyo, Japan		DE96704396	
96704397	20:29416	OSTI; NTIS; Available from New Energy and Industrial Technology Development Organization, Sunshine 60, 30F 1-1, 3-chome, Higashi-Ikebukuro, Toshima-ku, Tokyo, Japan		DE96704397	
96704398	20:29817	OSTI; NTIS; Available from New Energy and Industrial Technology Development Organization, Sunshine 60, 30F 1-1, 3-chome, Higashi-Ikebukuro, Toshima-ku, Tokyo, Japan		DE96704398	

Report Number	Abstract Number	Source of Availability	GPO Dep.	Order Number	Distribution Category
96704399	20:29385	OSTI; NTIS; Available from New Energy and Industrial Technology Development Organization, Sunshine 60, 30F 1-1, 3-chome, Higashi-Ikebukuro, Toshima-ku, Tokyo, Japan		DE96704399	
96704400	20:29386	OSTI; NTIS; Available from New Energy and Industrial Technology Development Organization, Sunshine 60, 30F 1-1, 3-chome, Higashi-Ikebukuro, Toshima-ku, Tokyo, Japan		DE96704400	
96704402	20:29417	OSTI; NTIS; Available from New Energy and Industrial Technology Development Organization, Sunshine 60, 30F 1-1, 3-chome, Higashi-Ikebukuro, Toshima-ku, Tokyo, Japan		DE96704402	
FE-MIT–					
89773-FINAL	20:28637	*See* DOE/PC/89773–T4			
FEMP–					
2362B	20:29088	OSTI; NTIS; INIS; GPO Dep.	E 1.99:	DE96000318	MF-2010
FEMP/SUB–					
095	20:29089	OSTI; NTIS; INIS; GPO Dep.	E 1.99:	DE96000317	MF-2010
096	20:29090	OSTI; NTIS; INIS; GPO Dep.	E 1.99:	DE96000319	MF-2010
102	20:29025	OSTI; NTIS; INIS; GPO Dep.	E 1.99:	DE96000320	MF-2000
FERMILAB/TM–					
1940	20:30801	OSTI; NTIS; INIS; GPO Dep.	E 1.99:	DE96000316	MF-414
FNAL–					
C-95/165-E	20:30997	OSTI; NTIS; INIS; GPO Dep.	E 1.99:	DE95016194	MF-414
FNAL-TM–					
1933	20:30446	OSTI; NTIS; INIS; GPO Dep.	E 1.99:	DE95017627	MF-414
1947	20:30422	OSTI; NTIS; INIS; GPO Dep.	E 1.99:	DE96000442	MF-414
FNAL/C–					
162-E	20:31028	OSTI; NTIS; INIS; GPO Dep.	E 1.99:	DE95016488	MF-414
212-E	20:30966	OSTI; NTIS; INIS; GPO Dep.	E 1.99:	DE95016387	MF-414
222-E	20:31002	OSTI; NTIS; INIS; GPO Dep.	E 1.99:	DE95016197	MF-414
229-E	20:31003	OSTI; NTIS; INIS; GPO Dep.	E 1.99:	DE95016195	MF-414
233-E	20:31004	OSTI; NTIS; INIS; GPO Dep.	E 1.99:	DE95016196	MF-414
95-237-E	20:31026	OSTI; NTIS; INIS; GPO Dep.	E 1.99:	DE95016487	MF-414
95/120	20:30880	OSTI; NTIS; INIS; GPO Dep.	E 1.99:	DE95015166	MF-414
95/141-E	20:30508	OSTI; NTIS; INIS; GPO Dep.	E 1.99:	DE95014574	MF-414
95/152-E	20:30996	OSTI; NTIS; INIS; GPO Dep.	E 1.99:	DE95013873	MF-414
95/174-E	20:30998	OSTI; NTIS; INIS; GPO Dep.	E 1.99:	DE96000261	MF-411
95/184-E	20:31022	OSTI; NTIS; INIS; GPO Dep.	E 1.99:	DE96000439	MF-414
95/190-E	20:31023	OSTI; NTIS; INIS; GPO Dep.	E 1.99:	DE96000441	MF-414
95/192-E	20:30963	OSTI; NTIS; INIS; GPO Dep.	E 1.99:	DE95016698	MF-414
95/201-E	20:30999	OSTI; NTIS; INIS; GPO Dep.	E 1.99:	DE95016699	MF-414
95/205-E	20:31000	OSTI; NTIS; INIS; GPO Dep.	E 1.99:	DE95017462	MF-414
95/211-E	20:31024	OSTI; NTIS; INIS; GPO Dep.	E 1.99:	DE95016648	MF-414
95/223-E	20:31025	OSTI; NTIS; INIS; GPO Dep.	E 1.99:	DE95017464	MF-414
95/239-E	20:30509	OSTI; NTIS; INIS; GPO Dep.	E 1.99:	DE95016199	MF-414
95/249-E	20:31001	OSTI; NTIS; INIS; GPO Dep.	E 1.99:	DE95016198	MF-414
95/259-E	20:30964	OSTI; NTIS; INIS; GPO Dep.	E 1.99:	DE96000410	MF-414
95/268	20:30420	OSTI; NTIS; INIS; GPO Dep.	E 1.99:	DE96000106	MF-414
95/269	20:30421	OSTI; NTIS; INIS; GPO Dep.	E 1.99:	DE96000109	MF-414
95/277-E	20:30965	OSTI; NTIS; INIS; GPO Dep.	E 1.99:	DE96000107	MF-414
95/288	20:31027	OSTI; NTIS; INIS; GPO Dep.	E 1.99:	DE96000108	MF-414
FZR–					
93	20:30025	OSTI; NTIS (US Sales Only); INIS		DE96706582	
GA–					
A22038	20:31213	OSTI; NTIS; INIS; GPO Dep.	E 1.99:	DE95017845	MF-426
GA-A–					
21935	20:31212	OSTI; NTIS; INIS; GPO Dep.	E 1.99:	DE95015977	PC-420
22050-Rev.1	20:31161	OSTI; NTIS; INIS; GPO Dep.	E 1.99:	DE96000804	MF-422
22081	20:31214	OSTI; NTIS; INIS; GPO Dep.	E 1.99:	DE95016481	MF-414
GA-C–					
21941	20:31215	OSTI; NTIS; INIS; GPO Dep.	E 1.99:	DE95017612	MF-420
GAO/PEMD–					
95-7	20:29971	OSTI; U.S. General Accounting Office, P.O. Box 6015, Gaithersburg, MD 20884-6015 (United States); (phone) 202-512-6000; (fax) 301-258-4066; (TDD) 301-413-0006.		TI95016474	

Report Number	Abstract Number	Source of Availability	GPO Dep.	Order Number	Distribution Category
GKSS–					
94/E/64	20:30655	OSTI; NTIS (US Sales Only)		DE96706569	
GSF–					
24/94	20:30708	OSTI; NTIS (US Sales Only); INIS		DE96706554	
Hep-th–					
9506151	20:30933	*See* IC–95/151			
9506152	20:30934	*See* IC–95/152			
IAE–					
0141.	20:30504	*See* CNIC–00925			
IAEA-ITEREDA/DS–					
06	20:31216	OSTI; NTIS (US Sales Only); INIS		DE96602912	
IAEA-NDS–					
0(rev.95/7)	20:31395	OSTI; NTIS (US Sales Only); INIS		DE96602790	
100(rev.6)	20:31053	OSTI; NTIS (US Sales Only); INIS		DE96602858	
104(rev.1)	20:31038	OSTI; NTIS (US Sales Only); INIS		DE96602836	
106(rev.3)	20:31054	OSTI; NTIS (US Sales Only); INIS		DE96602878	
107(rev.10)	20:31055	OSTI; NTIS (US Sales Only); INIS		DE96602859	
128(rev.1)	20:31056	OSTI; NTIS (US Sales Only); INIS		DE96602860	
129(rev.2)	20:31057	OSTI; NTIS (US Sales Only); INIS		DE96602861	
136(rev.1)	20:31058	OSTI; NTIS (US Sales Only); INIS		DE96602862	
137(rev.2)	20:31059	OSTI; NTIS (US Sales Only); INIS		DE96602863	
143	20:31060	OSTI; NTIS (US Sales Only); INIS		DE96602864	
150(rev.95/6)	20:31397	OSTI; NTIS (US Sales Only); INIS		DE96602789	
161	20:31039	OSTI; NTIS (US Sales Only); INIS		DE96602837	
162	20:31042	OSTI; NTIS (US Sales Only); INIS		DE96602844	
169(rev.2)	20:31061	OSTI; NTIS (US Sales Only); INIS		DE96602865	
170	20:31062	OSTI; NTIS (US Sales Only); INIS		DE96602866	
197	20:31094	OSTI; NTIS (US Sales Only); INIS		DE96602880	
7(rev.95/7)	20:31396	OSTI; NTIS (US Sales Only); INIS		DE96602791	
IAEA-TECDOC–					
782	20:28763	OSTI; NTIS (US Sales Only); INIS		DE96602584	
794	20:30026	OSTI; NTIS (US Sales Only); INIS		DE96602538	
801	20:29448	OSTI; NTIS (US Sales Only); INIS		DE96602724	
803	20:29466	OSTI; NTIS (US Sales Only); INIS		DE96602727	
IASSNS-HEP–					
94/105.	20:31034	*See* UM-P–94/113			
IC–					
95/100	20:31106	OSTI; NTIS (US Sales Only); INIS		DE96602305	
95/101	20:30855	OSTI; NTIS (US Sales Only); INIS		DE96602150	
95/102	20:31117	OSTI; NTIS (US Sales Only); INIS		DE96602365	
95/104	20:30709	OSTI; NTIS (US Sales Only); INIS		DE96601754	
95/105	20:30967	OSTI; NTIS (US Sales Only); INIS		DE96602198	
95/106	20:30881	OSTI; NTIS (US Sales Only); INIS		DE96602808	
95/107	20:30856	OSTI; NTIS (US Sales Only); INIS		DE96602151	
95/108	20:30923	OSTI; NTIS (US Sales Only); INIS		DE96602809	
95/109	20:30924	OSTI; NTIS (US Sales Only); INIS		DE96602196	
95/110	20:31064	OSTI; NTIS (US Sales Only); INIS		DE96602272	
95/111	20:30925	OSTI; NTIS (US Sales Only); INIS		DE96602811	
95/112	20:31005	OSTI; NTIS (US Sales Only); INIS		DE96602217	
95/113	20:30926	OSTI; NTIS (US Sales Only); INIS		DE96602179	
95/114	20:30927	OSTI; NTIS (US Sales Only); INIS		DE96602180	
95/116	20:30847	OSTI; NTIS (US Sales Only); INIS		DE96602585	
95/117	20:31029	OSTI; NTIS (US Sales Only); INIS		DE96602224	
95/118	20:30968	OSTI; NTIS (US Sales Only); INIS		DE96602199	
95/119	20:30108	OSTI; NTIS (US Sales Only); INIS		DE96601679	
95/120	20:30969	OSTI; NTIS (US Sales Only); INIS		DE96602205	
95/121	20:31118	OSTI; NTIS (US Sales Only); INIS		DE96602366	
95/122	20:30970	OSTI; NTIS (US Sales Only); INIS		DE96602200	
95/123	20:31124	OSTI; NTIS (US Sales Only); INIS		DE96602373	
95/124	20:31140	OSTI; NTIS (US Sales Only); INIS		DE96602437	
95/127	20:30857	OSTI; NTIS (US Sales Only); INIS		DE96602152	
95/128	20:30882	OSTI; NTIS (US Sales Only); INIS		DE96602170	
95/129	20:30858	OSTI; NTIS (US Sales Only); INIS		DE96602153	
95/131	20:30928	OSTI; NTIS (US Sales Only); INIS		DE96602176	
95/132	20:30510	OSTI; NTIS (US Sales Only); INIS		DE96602042	
95/134	20:30971	OSTI; NTIS (US Sales Only); INIS		DE96602206	
95/135	20:30929	OSTI; NTIS (US Sales Only); INIS		DE96602177	
95/136	20:30930	OSTI; NTIS (US Sales Only); INIS		DE96602182	
95/137	20:31119	OSTI; NTIS (US Sales Only); INIS		DE96602367	
95/138	20:30931	OSTI; NTIS (US Sales Only); INIS		DE96602183	
95/139	20:31046	OSTI; NTIS (US Sales Only); INIS		DE96602251	

Report Number	Abstract Number	Source of Availability	GPO Dep.	Order Number	Distribution Category
95/141	20:31141	OSTI; NTIS (US Sales Only); INIS		DE96602438	
95/143	20:30883	OSTI; NTIS (US Sales Only); INIS		DE96602171	
95/147	20:30848	OSTI; NTIS (US Sales Only); INIS		DE96602586	
95/150	20:30932	OSTI; NTIS (US Sales Only); INIS		DE96602812	
95/151	20:30933	OSTI; NTIS (US Sales Only); INIS		DE96602184	
95/152	20:30934	OSTI; NTIS (US Sales Only); INIS		DE96602185	
95/153	20:31142	OSTI; NTIS (US Sales Only); INIS		DE96602966	
95/154	20:31143	OSTI; NTIS (US Sales Only); INIS		DE96602439	
95/156	20:31144	OSTI; NTIS (US Sales Only); INIS		DE96602967	
95/162	20:30027	OSTI; NTIS (US Sales Only); INIS		DE96602539	
95/171	20:30935	OSTI; NTIS (US Sales Only); INIS		DE96602818	
95/172	20:30936	OSTI; NTIS (US Sales Only); INIS		DE96602810	
95/174	20:31043	OSTI; NTIS (US Sales Only); INIS		DE96602246	
95/181	20:31145	OSTI; NTIS (US Sales Only); INIS		DE96602968	
95/182	20:31146	OSTI; NTIS (US Sales Only); INIS		DE96602969	
95/183	20:31147	OSTI; NTIS (US Sales Only); INIS		DE96602970	
95/194	20:31148	OSTI; NTIS (US Sales Only); INIS		DE96602971	
95/57	20:30921	OSTI; NTIS (US Sales Only); INIS		DE96602186	
95/74	20:30922	OSTI; NTIS (US Sales Only); INIS		DE96602187	
95/90	20:31063	OSTI; NTIS (US Sales Only); INIS		DE96602273	
95/99	20:30656	OSTI; NTIS (US Sales Only); INIS		DE96601763	
IFVE-OEF–					
94-26	20:30511	OSTI; NTIS (US Sales Only); INIS		DE96602030	
IFVE-OKU–					
94-100	20:30448	OSTI; NTIS (US Sales Only); INIS		DE96601960	
94-30	20:30402	OSTI; NTIS (US Sales Only); INIS		DE96601945	
94-93	20:30447	OSTI; NTIS (US Sales Only); INIS		DE96601958	
IFVE-OLU–					
94-105	20:30449	OSTI; NTIS (US Sales Only); INIS		DE96601962	
IFVE-OP–					
94-28	20:30450	OSTI; NTIS (US Sales Only); INIS		DE96601963	
IFVE-ORI–					
94-112	20:30423	OSTI; NTIS (US Sales Only); INIS		DE96601951	
IFVE-OTF–					
94-64	20:30937	OSTI; NTIS (US Sales Only); INIS		DE96602188	
94-86	20:30972	OSTI; NTIS (US Sales Only); INIS		DE96602207	
ILAS/FM–					
13/1995.	20:30924	*See* IC–95/109			
INDC(CPR)–					
035	20:31095	OSTI; NTIS (US Sales Only); INIS		DE96602280	
INDC(NDS)–					
313	20:31096	OSTI; NTIS (US Sales Only); INIS		DE96602281	
314	20:31097	OSTI; NTIS (US Sales Only); INIS		DE96602282	
315	20:31098	OSTI; NTIS (US Sales Only); INIS		DE96602283	
336	20:31302	OSTI; NTIS (US Sales Only); INIS		DE96602143	
INDC(PAK)–					
009	20:31065	OSTI; NTIS (US Sales Only); INIS		DE96602255	
010	20:31066	OSTI; NTIS (US Sales Only); INIS		DE96602256	
011	20:31067	OSTI; NTIS (US Sales Only); INIS		DE96602257	
INEL–					
94/00081	20:31336	OSTI; NTIS; GPO Dep.	E 1.99:	DE96001622	MF-405
94/00106	20:30287	OSTI; NTIS; INIS; GPO Dep.	E 1.99:	DE96001616	MF-2000
94/00120	20:28830	OSTI; NTIS; INIS; GPO Dep.	E 1.99:	DE96001441	MF-721
94/0095	20:28828	OSTI; NTIS; INIS; GPO Dep.	E 1.99:	DE96001325	MF-2020
94/0119	20:28829	OSTI; NTIS; INIS; GPO Dep.	E 1.99:	DE96001338	MF-2000
94/0156	20:29517	*See* NUREG/CR–6100			
95/00079	20:30288	OSTI; NTIS; GPO Dep.	E 1.99:	DE96001625	
95/00080	20:29091	OSTI; NTIS; INIS; GPO Dep.	E 1.99:	DE96001626	
95/00106	20:30884	OSTI; NTIS; GPO Dep.	E 1.99:	DE96001614	MF-700
95/0013	20:28831	OSTI; NTIS; INIS; GPO Dep.	E 1.99:	DE96001353	MF-2000
95/00137	20:28838	OSTI; NTIS; INIS; GPO Dep.	E 1.99:	DE96001615	MF-2000
95/0014-Rev.1	20:28832	OSTI; NTIS; INIS; GPO Dep.	E 1.99:	DE96001352	MF-2020
95/0016-Rev.1	20:28833	OSTI; NTIS; INIS; GPO Dep.	E 1.99:	DE96001351	MF-2000
95/00174	20:29523	OSTI; NTIS; GPO Dep.	E 1.99:	DE96001624	

Report Number	Abstract Number	Source of Availability	GPO Dep.	Order Number	Distribution Category
95/00320	20:28847	OSTI; NTIS; INIS; GPO Dep.	E 1.99:	DE96001612	MF-2000
95/0036	20:28834	OSTI; NTIS; INIS; GPO Dep.	E 1.99:	DE96001183	MF-2000
95/00381	20:29581	OSTI; NTIS; INIS; GPO Dep.	E 1.99:	DE96001617	
95/00444	20:30657	OSTI; NTIS; INIS; GPO Dep.	E 1.99:	DE96001613	MF-702
95/0054	20:28835	OSTI; NTIS; INIS; GPO Dep.	E 1.99:	DE96001189	MF-2020
95/0101	20:30710	OSTI; NTIS; INIS; GPO Dep.	E 1.99:	DE96001355	MF-2070
95/0114	20:28836	OSTI; NTIS; INIS; GPO Dep.	E 1.99:	DE96001356	MF-2000
95/0129	20:28837	OSTI; NTIS; INIS; GPO Dep.	E 1.99:	DE96000981	MF-2020
95/0132(94)	20:30711	OSTI; NTIS; INIS; GPO Dep.	E 1.99:	DE95017523	PC-2050
95/0161	20:28839	OSTI; NTIS; INIS; GPO Dep.	E 1.99:	DE96001181	MF-2000
95/0164	20:28840	OSTI; NTIS; INIS; GPO Dep.	E 1.99:	DE96001180	MF-2000
95/0167	20:28779	OSTI; NTIS; INIS; GPO Dep.	E 1.99:	DE95017516	MF-2000
95/0174-Vol.1	20:29772	*See* NUREG/CR–5535-Vol.1			
95/0174-Vol.4	20:29773	*See* NUREG/CR–5535-Vol.4			
95/0182	20:29092	OSTI; NTIS; INIS; GPO Dep.	E 1.99:	DE95017629	MF-2000
95/0185	20:30823	OSTI; NTIS; INIS; GPO Dep.	E 1.99:	DE96001340	MF-2000
95/0194	20:28841	OSTI; NTIS; INIS; GPO Dep.	E 1.99:	DE96001339	MF-2000
95/0224	20:28842	OSTI; NTIS; INIS; GPO Dep.	E 1.99:	DE96001188	MF-2070
95/0225	20:28843	OSTI; NTIS; INIS; GPO Dep.	E 1.99:	DE96001184	MF-2000
95/0272	20:28844	OSTI; NTIS; INIS; GPO Dep.	E 1.99:	DE96001336	MF-2000
95/0273	20:28845	OSTI; NTIS; INIS; GPO Dep.	E 1.99:	DE96001354	MF-2000
95/0274	20:29093	OSTI; NTIS; GPO Dep.	E 1.99:	DE96001366	MF-607
95/0302	20:28846	OSTI; NTIS; INIS; GPO Dep.	E 1.99:	DE96001337	MF-2000
95/0309	20:29972	OSTI; NTIS; GPO Dep.	E 1.99:	DE96001372	MF-1501
95/0321	20:28848	OSTI; NTIS; INIS; GPO Dep.	E 1.99:	DE96001335	MF-2000
95/0384	20:28765	OSTI; NTIS; INIS; GPO Dep.	E 1.99:	DE96001187	MF-2000
95/0414	20:28849	OSTI; NTIS; INIS; GPO Dep.	E 1.99:	DE96001186	MF-721
95/0422	20:29094	OSTI; NTIS; INIS; GPO Dep.	E 1.99:	DE96001367	MF-2000
95/0442	20:28850	OSTI; NTIS; INIS; GPO Dep.	E 1.99:	DE96001334	MF-2030
INIS-BR–					
3541	20:30109	OSTI; NTIS; INIS		DE96602555	
3542	20:30813	OSTI; NTIS; INIS		DE96602603	
3543	20:30824	OSTI; NTIS; INIS		DE96602644	
3545	20:30814	OSTI; NTIS; INIS		DE96602626	
3546	20:30802	OSTI; NTIS; INIS		DE96602666	
3547	20:30028	OSTI; NTIS; INIS		DE96602535	
3548	20:29793	OSTI; NTIS; INIS		DE96602780	
3549	20:30199	OSTI; NTIS; INIS		DE96602455	
3550	20:29794	OSTI; NTIS; INIS		DE96602781	
3551	20:30712	OSTI; NTIS; INIS		DE96602581	
3552	20:29795	OSTI; NTIS; INIS		DE96602782	
3553	20:30803	OSTI; NTIS; INIS		DE96602673	
INIS-JP–					
032	20:31303	OSTI; NTIS; INIS		DE96701431	
041	20:31304	OSTI; NTIS (US Sales Only); INIS; Available from the Research Reactor Institute, Kyoto Univ., Kumatori-cho, Sennan-gun, Osaka-fu 590-04 (Japan)		DE95776795	

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INIS-mf–					
14565	20:31305	OSTI; NTIS (US Sales Only); INIS		DE96602799	
14566	20:29859	OSTI; NTIS (US Sales Only); INIS		DE96602760	
14568	20:29860	OSTI; NTIS (US Sales Only); INIS		DE96602761	
14569	20:31306	OSTI; NTIS (US Sales Only); INIS		DE96602800	
14570	20:31307	OSTI; NTIS (US Sales Only); INIS		DE96602801	
14572	20:29861	OSTI; NTIS (US Sales Only); INIS		DE96602763	
14573	20:29862	OSTI; NTIS (US Sales Only); INIS		DE96602764	
14574	20:29863	OSTI; NTIS (US Sales Only); INIS		DE96602765	
14575	20:29864	OSTI; NTIS (US Sales Only); INIS		DE96602766	
14576	20:29126	OSTI; NTIS (US Sales Only); INIS		DE96602793	
14577	20:31217	OSTI; NTIS (US Sales Only); INIS		DE96602913	
14578	20:31218	OSTI; NTIS (US Sales Only); INIS		DE96602914	
14579	20:31219	OSTI; NTIS (US Sales Only); INIS		DE96602915	
14580	20:31220	OSTI; NTIS (US Sales Only); INIS		DE96602916	
14581	20:30825	OSTI; NTIS; INIS		DE96602646	
14583	20:30336	OSTI; NTIS (US Sales Only); INIS		DE96602711	
14585	20:30233	OSTI; NTIS (US Sales Only); INIS		DE96602478	
14586	20:30030	OSTI; NTIS (US Sales Only); INIS		DE96602536	
14587	20:30337	OSTI; NTIS (US Sales Only); INIS		DE96602713	
14588	20:29494	OSTI; NTIS (US Sales Only); INIS		DE96602759	
14589	20:30110	OSTI; NTIS (US Sales Only); INIS		DE96602556	
14590	20:30234	OSTI; NTIS (US Sales Only); INIS		DE96602472	
14591	20:28769	OSTI; NTIS (US Sales Only); INIS		DE96602534	
14592	20:29155	OSTI; NTIS (US Sales Only); INIS		DE96602677	
14593	20:29531	OSTI; NTIS (US Sales Only); INIS		DE96602732	
14594	20:30200	OSTI; NTIS (US Sales Only); INIS		DE96602454	
14595	20:30251	OSTI; NTIS (US Sales Only); INIS		DE96602531	
14598	20:30816	OSTI; NTIS (US Sales Only); INIS		DE96602627	
14601	20:31398	OSTI; NTIS (US Sales Only); INIS		DE96602792	
14602	20:31162	OSTI; NTIS (US Sales Only); INIS		DE96602895	
15119	20:29524	OSTI; NTIS (US Sales Only); INIS		DE96706557	
INS-J–					
180	20:31047	OSTI; NTIS; INIS		DE96701435	
181	20:30918	OSTI; NTIS; INIS		DE96701433	
INS-T–					
535	20:30919	OSTI; NTIS; INIS		DE96701434	
IS–					
5102-Exec.Summ.	20:28853	OSTI; NTIS; INIS; GPO Dep.	E 1.99:	DE96000896	MF-630
5102-Pt.1	20:28854	OSTI; NTIS; INIS; GPO Dep.	E 1.99:	DE96000895	MF-630
5102-Pt.2-Vol.1	20:28855	OSTI; NTIS; INIS; GPO Dep.	E 1.99:	DE96000897	MF-630
5102-Pt.2-Vol.2	20:28856	OSTI; NTIS; INIS; GPO Dep.	E 1.99:	DE96000898	MF-630
5115	20:29026	OSTI; NTIS; INIS; GPO Dep.	E 1.99:	DE96000889	MF-606
5117	20:30713	OSTI; NTIS; INIS; GPO Dep.	E 1.99:	DE96000214	MF-2070
IS-M–					
825	20:30165	OSTI; NTIS; GPO Dep.	E 1.99:	DE96000212	MF-404
826	20:30031	OSTI; NTIS; GPO Dep.	E 1.99:	DE96000211	MF-404
827	20:30032	OSTI; NTIS; GPO Dep.	E 1.99:	DE96000213	MF-404
828	20:30111	OSTI; NTIS; INIS; GPO Dep.	E 1.99:	DE96000210	MF-404
829	20:30112	OSTI; NTIS; INIS; GPO Dep.	E 1.99:	DE96000209	MF-404
830	20:28656	OSTI; NTIS; GPO Dep.	E 1.99:	DE96000208	MF-107
IS-T–					
1722	20:28628	OSTI; NTIS; GPO Dep.	E 1.99:	DE96000222	MF-401
1723	20:30113	OSTI; NTIS; GPO Dep.	E 1.99:	DE96000221	MF-404
1731	20:31127	OSTI; NTIS; GPO Dep.	E 1.99:	DE96000223	MF-404
1735	20:30033	OSTI; NTIS; GPO Dep.	E 1.99:	DE96000886	MF-404
1737	20:30114	OSTI; NTIS; GPO Dep.	E 1.99:	DE96000219	MF-404
1738	20:30166	OSTI; NTIS; GPO Dep.	E 1.99:	DE96000220	MF-401
1739	20:30245	OSTI; NTIS; GPO Dep.	E 1.99:	DE96000218	MF-401; MF-404
1740	20:30201	OSTI; NTIS; GPO Dep.	E 1.99:	DE96000217	MF-401
1742	20:30202	OSTI; NTIS; INIS; GPO Dep.	E 1.99:	DE96000215	MF-410
ITER/US–					
95/IV-MAT-10	20:29993	*See* ANL/FPP/TM–287			
JAERI–					
1332	20:29532	OSTI; NTIS; INIS		DE96701486	
JAERI-Conf–					
95-004	20:31048	OSTI; NTIS; INIS		DE96701432	
95-017	20:30399	OSTI; NTIS; INIS		DE96701438	

Report Number	Abstract Number	Source of Availability	GPO Dep.	Order Number	Distribution Category
JAERI-Data/Code–					
95-005	20:29484	OSTI; NTIS; INIS		DE96701325	
95-007	20:30289	OSTI; NTIS; INIS		DE96701321	
JAERI-Research–					
95-019	20:28857	OSTI; NTIS; INIS		DE96701323	
95-037	20:30034	OSTI; NTIS; INIS		DE96701326	
95-041	20:31178	OSTI; NTIS; INIS		DE96701322	
95-044	20:30714	OSTI; NTIS; INIS		DE96701327	
95-046	20:28858	OSTI; NTIS; INIS		DE96701391	
95-047	20:29170	OSTI; NTIS; INIS		DE96701398	
JAERI-Review–					
95-006	20:29458	OSTI; NTIS; INIS		DE96701320	
95-010	20:29539	OSTI; NTIS; INIS		DE96701319	
95-011	20:30715	OSTI; NTIS; INIS		DE96701390	
JAERI-Tech–					
94-038	20:29485	OSTI; NTIS; INIS		DE96701487	
95-032	20:31221	OSTI; NTIS; INIS		DE96701317	
95-033	20:31222	OSTI; NTIS; INIS		DE96701318	
JP–					
432	20:28766	OSTI; NTIS; GPO Dep.	E 1.99:	DE95012597	MF-500
K/ETO–					
140-Rev.1	20:30236	OSTI; NTIS; INIS; GPO Dep.	E 1.99:	DE95017843	MF-401; MF-405
167	20:29906	OSTI; NTIS; GPO Dep.	E 1.99:	DE95017848	MF-500
K/WM–					
96	20:28859	OSTI; NTIS; INIS; GPO Dep.	E 1.99:	DE96000422	MF-2010
KA–					
02-01	20:30442	*See* BNL–61797			
KA-CE–					
027-92049403	20:28755	OSTI; NTIS (US Sales Only)		DE96703558	
KA-EE–					
066-94089412	20:28749	OSTI; NTIS (US Sales Only)		DE96703555	
067-94089412	20:28750	OSTI; NTIS (US Sales Only)		DE96703554	
KA-FU–					
025-92039409	20:28756	OSTI; NTIS (US Sales Only)		DE96703551	
046-93029412	20:28744	OSTI; NTIS (US Sales Only)		DE96703553	
KAERI-NEMAC/RR–					
113/94	20:30235	OSTI; NTIS (US Sales Only)		DE95778398	
153D/94	20:29495	OSTI; NTIS (US Sales Only)		DE96703674	
KB-CR–					
032-92099412	20:28757	OSTI; NTIS (US Sales Only)		DE96703550	
KCP–					
613-5564	20:30362	OSTI; NTIS; GPO Dep.	E 1.99:	DE96001629	MF-706
613-5602	20:30716	OSTI; NTIS; GPO Dep.	E 1.99:	DE95017314	MF-706
613-5658	20:29841	OSTI; NTIS; INIS; GPO Dep.	E 1.99:	DE95017313	MF-702
KD-FU–					
044-93029412	20:28745	OSTI; NTIS (US Sales Only)		DE96703552	
045-93029411	20:28758	OSTI; NTIS (US Sales Only)		DE96703548	
KEK–					
95-5	20:30492	OSTI; NTIS; INIS		DE96701329	
KFK–					
5380	20:30658	OSTI; NTIS (US Sales Only)		DE96706558	
5423	20:30659	OSTI; NTIS (US Sales Only)		DE96706553	
5438	20:30557	OSTI; NTIS (US Sales Only)		DE96706559	
KRC–					
88S-J10	20:31150	OSTI; NTIS (US Sales Only)		DE96703604	
89A-J03	20:30541	OSTI; NTIS (US Sales Only)		DE96703559	
89A-J10	20:30542	OSTI; NTIS (US Sales Only)		DE96703568	
89G-J05	20:29432	OSTI; NTIS (US Sales Only)		DE96703584	
90C-T05	20:30660	OSTI; NTIS (US Sales Only)		DE96703575	
90C04	20:28644	OSTI; NTIS (US Sales Only)		DE96703577	
90D-J03	20:29807	OSTI; NTIS (US Sales Only)		DE96703581	
90G-05	20:30290	OSTI; NTIS (US Sales Only)		DE96703585	
90G-J06	20:30291	OSTI; NTIS (US Sales Only)		DE96703590	
90G-J07	20:28629	CSTI; NTIS (US Sales Only)		DE96703593	
90G-S03	20:29890	OSTI; NTIS (US Sales Only)		DE96703588	
90I-J02	20:30355	OSTI; NTIS (US Sales Only)		DE96703598	
90I-J03	20:29426	OSTI; NTIS (US Sales Only)		DE96703610	
90N-J04	20:29496	OSTI; NTIS (US Sales Only)		DE96703603	
91A-J03	20:31289	OSTI; NTIS (US Sales Only)		DE96703570	

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91A-J04	20:31290	OSTI; NTIS (US Sales Only)		DE96703569	
91A-J05	20:31291	OSTI; NTIS (US Sales Only)		DE96703561	
91A-S01	20:31292	OSTI; NTIS (US Sales Only)		DE96703560	
91C-J01	20:29525	OSTI; NTIS (US Sales Only)		DE96703578	
91C-T02	20:29445	OSTI; NTIS (US Sales Only)		DE96703573	
91D-J01	20:29785	OSTI; NTIS (US Sales Only)		DE96703579	
91D-J03	20:29789	OSTI; NTIS (US Sales Only)		DE96703580	
91G-J02	20:29433	OSTI; NTIS (US Sales Only)		DE96703587	
91G-J03	20:28675	OSTI; NTIS (US Sales Only)		DE96703592	
91G-J07	20:29393	OSTI; NTIS (US Sales Only)		DE96703594	
91G-S05	20:29434	OSTI; NTIS (US Sales Only)		DE96703583	
91G-T06	20:30338	OSTI; NTIS (US Sales Only)		DE96703589	
91H-J01	20:29907	OSTI; NTIS (US Sales Only)		DE96703597	
91I-J02	20:29427	OSTI; NTIS (US Sales Only)		DE96703611	
91S-J03	20:29780	OSTI; NTIS (US Sales Only)		DE96703608	
91S-J04	20:29790	OSTI; NTIS (US Sales Only)		DE96703606	
91S-S02	20:29781	OSTI; NTIS (US Sales Only)		DE96703609	
91S-S05	20:29779	OSTI; NTIS (US Sales Only)		DE96703607	
92A-J02	20:30543	OSTI; NTIS (US Sales Only)		DE96703563	
92A-J03	20:30544	OSTI; NTIS (US Sales Only)		DE96703564	
92A-J07	20:31399	OSTI; NTIS (US Sales Only)		DE96703562	
92A-S06	20:31293	OSTI; NTIS (US Sales Only)		DE96703566	
92C-01	20:30773	OSTI; NTIS (US Sales Only)		DE96703572	
92C-02	20:29467	OSTI; NTIS (US Sales Only)		DE96703574	
92C-J03	20:29468	OSTI; NTIS (US Sales Only)		DE96703571	
92C-S05	20:30167	OSTI; NTIS (US Sales Only)		DE96703576	
92H-J01	20:30292	OSTI; NTIS (US Sales Only)		DE96703595	
92H-J02	20:31337	OSTI; NTIS (US Sales Only)		DE96703596	
92N-J04	20:29519	OSTI; NTIS (US Sales Only)		DE96703602	
92N-J08	20:29526	OSTI; NTIS (US Sales Only)		DE96703600	
92N-S01	20:30826	OSTI; NTIS (US Sales Only)		DE96703599	
92S-J08	20:29786	OSTI; NTIS (US Sales Only)		DE96703605	
93A-T05	20:31400	OSTI; NTIS (US Sales Only)		DE96703565	
93A-T08	20:31294	OSTI; NTIS (US Sales Only)		DE96703567	
93G-S05	20:30293	OSTI; NTIS (US Sales Only)		DE96703582	
93G-S08	20:29435	OSTI; NTIS (US Sales Only)		DE96703586	
93N-07	20:31401	OSTI; NTIS (US Sales Only)		DE96703601	
93Y-T03	20:29436	OSTI; NTIS (US Sales Only)		DE96703591	
L–					
19757-1	20:30811	*See* UCRL-ID–121808			
LA–					
10228-Del.	20:30339	OSTI; NTIS; GPO Dep.	E 1.99:	DE96001359	MF-705
12809-Pt.1	20:29423	OSTI; NTIS; GPO Dep.	E 1.99:	DE96000060	MF-1240
12906-PR	20:31099	OSTI; NTIS; INIS; GPO Dep.	E 1.99:	DE95016181	MF-414
12910-MS	20:30513	OSTI; NTIS; GPO Dep.	E 1.99:	DE95015052	MF-907
12912-MS	20:30717	OSTI; NTIS; GPO Dep.	E 1.99:	DE95015015	MF-2070
12926-PR	20:30774	OSTI; NTIS; GPO Dep.	E 1.99:	DE95017248	MF-903
12927-MS	20:29851	OSTI; NTIS; GPO Dep.	E 1.99:	DE95016383	MF-900
12968-MS	20:30718	OSTI; NTIS; GPO Dep.	E 1.99:	DE96000894	MF-2070
12988-MS	20:30602	OSTI; NTIS; GPO Dep.	E 1.99:	DE96000892	MF-705
12996-MS	20:28767	OSTI; NTIS; INIS; GPO Dep.	E 1.99:	DE96000059	MF-704
13000	20:28860	OSTI; NTIS; INIS; GPO Dep.	E 1.99:	DE96000291	PC-2030
13003	20:30582	OSTI; NTIS; GPO Dep.	E 1.99:	DE96000052	MF-741
13015-MS	20:29027	OSTI; NTIS; INIS; GPO Dep.	E 1.99:	DE96000058	MF-2000
13019-MS	20:30839	OSTI; NTIS; GPO Dep.	E 1.99:	DE96000890	MF-902
13023-MS	20:30887	OSTI; NTIS; GPO Dep.	E 1.99:	DE96001439	MF-902
13027-M	20:30603	OSTI; NTIS; GPO Dep.	E 1.99:	DE96000054	MF-706
13028-MS	20:29028	OSTI; NTIS; INIS; GPO Dep.	E 1.99:	DE96000053	MF-2070
13031-MS	20:31338	OSTI; NTIS; GPO Dep.	E 1.99:	DE96001358	MF-905
13036-MS	20:30719	OSTI; NTIS; GPO Dep.	E 1.99:	DE96000885	MF-903
13041-MS	20:28861	OSTI; NTIS; INIS; GPO Dep.	E 1.99:	DE96000887	MF-2020
LA-SUB–					
93-134	20:29891	OSTI; NTIS; GPO Dep.	E 1.99:	DE96000170	MF-1505

Report Number	Abstract Number	Source of Availability	GPO Dep.	Order Number	Distribution Category
93-143	20:30604	OSTI; NTIS; GPO Dep.	E 1.99:	DE96000173	MF-706
93-149	20:29489	OSTI; NTIS; GPO Dep.	E 1.99:	DE96000182	
93-155	20:30035	OSTI; NTIS; GPO Dep.	E 1.99:	DE96000175	MF-704
93-156	20:30622	OSTI; NTIS; GPO Dep.	E 1.99:	DE96000174	
93-176	20:30567	OSTI; NTIS; GPO Dep.	E 1.99:	DE96000171	
93-180	20:30514	OSTI; NTIS; INIS; GPO Dep.	E 1.99:	DE96000183	MF-804
93-183	20:30568	OSTI; NTIS; GPO Dep.	E 1.99:	DE96000184	
95-101	20:30357	OSTI; NTIS; GPO Dep.	E 1.99:	DE95017361	MF-703; MF-900
95-102	20:30451	OSTI; NTIS; GPO Dep.	E 1.99:	DE95016318	MF-700
95-106	20:30583	OSTI; NTIS; GPO Dep.	E 1.99:	DE95017362	MF-741
95-109	20:30623	OSTI; NTIS; GPO Dep.	E 1.99:	DE96000861	
95-111	20:30799	OSTI; NTIS; GPO Dep.	E 1.99:	DE95017811	MF-408
95-112	20:31295	OSTI; NTIS; GPO Dep.	E 1.99:	DE95017807	MF-900
95-125	20:31403	OSTI; NTIS; GPO Dep.	E 1.99:	DE95017812	MF-900
95-137	20:29127	OSTI; NTIS; INIS; GPO Dep.	E 1.99:	DE95017809	MF-731
95-139	20:31296	OSTI; NTIS; GPO Dep.	E 1.99:	DE95017808	MF-700
95-142	20:29095	OSTI; NTIS; INIS; GPO Dep.	E 1.99:	DE96000103	MF-707; MF-705
95-143-PT.1	20:29822	OSTI; NTIS; GPO Dep.	E 1.99:	DE96000863	MF-900
95-143-Pt.2	20:29823	OSTI; NTIS; GPO Dep.	E 1.99:	DE96000298	MF-900
95-151	20:29583	OSTI; NTIS; GPO Dep.	E 1.99:	DE95017810	MF-530
95-161	20:31340	OSTI; NTIS; GPO Dep.	E 1.99:	DE96000858	MF-705
95-167	20:28862	OSTI; NTIS (US Sales Only); GPO Dep.	E 1.99:	DE96000859	MF-700
95-170	20:31404	OSTI; NTIS; GPO Dep.	E 1.99:	DE96000854	MF-731
95-172	20:31135	OSTI; NTIS; GPO Dep.	E 1.99:	DE96000860	MF-704
95-175-A:1	20:29584	OSTI; NTIS; INIS; GPO Dep.	E 1.99:	DE96000822	MF-406
95-175-A:3	20:29585	OSTI; NTIS; INIS; GPO Dep.	E 1.99:	DE96000823	MF-406
95-175-A:5	20:29586	OSTI; NTIS; INIS; GPO Dep.	E 1.99:	DE96000824	MF-424
95-177	20:30720	OSTI; NTIS; INIS; GPO Dep.	E 1.99:	DE96000862	MF-902
95-178	20:31341	OSTI; NTIS; GPO Dep.	E 1.99:	DE96000857	MF-705
95-60	20:31339	OSTI; NTIS; GPO Dep.	E 1.99:	DE95016515	MF-405
95-91	20:31308	OSTI; NTIS; GPO Dep.	E 1.99:	DE95014559	MF-900
95-99	20:31402	OSTI; NTIS; INIS; GPO Dep.	E 1.99:	DE95017359	MF-2050
LA-UR–					
95-1108	20:31344	OSTI; NTIS; GPO Dep.	E 1.99:	DE95009488	MF-905
95-1127	20:31345	OSTI; NTIS; GPO Dep.	E 1.99:	DE95009484	MF-405
95-1296	20:31346	OSTI; NTIS; GPO Dep.	E 1.99:	DE95010877	MF-905
95-1475	20:30889	OSTI; NTIS; GPO Dep.	E 1.99:	DE95011996	MF-910
95-1578	20:30452	OSTI; INIS; NTIS; GPO Dep.	E 1.99:	DE95015290	MF-414
95-1634	20:30890	OSTI; NTIS; GPO Dep.	E 1.99:	DE95015338	MF-910
95-1659	20:30849	OSTI; NTIS; GPO Dep.	E 1.99:	DE95015332	MF-405
95-1660	20:29128	OSTI; NTIS; INIS; GPO Dep.	E 1.99:	DE95015329	MF-700
95-1664	20:29921	OSTI; NTIS; GPO Dep.	E 1.99:	DE95016428	
95-1735	20:30891	OSTI; NTIS; GPO Dep.	E 1.99:	DE95015319	MF-412
95-1766	20:31347	OSTI; NTIS; GPO Dep.	E 1.99:	DE95015317	MF-405
95-1785	20:29587	OSTI; NTIS; INIS; GPO Dep.	E 1.99:	DE95015318	
95-1793	20:30453	OSTI; NTIS; INIS; GPO Dep.	E 1.99:	DE95016430	MF-414
95-1805	20:30203	OSTI; NTIS; INIS; GPO Dep.	E 1.99:	DE95015312	MF-940
95-1822	20:31008	OSTI; NTIS; INIS; GPO Dep.	E 1.99:	DE95015315	MF-414
95-1823	20:31348	OSTI; NTIS; GPO Dep.	E 1.99:	DE95015316	MF-905
95-1828	20:30721	OSTI; NTIS; INIS; GPO Dep.	E 1.99:	DE95015308	MF-721
95-1848	20:31120	OSTI; NTIS; GPO Dep.	E 1.99:	DE95016811	MF-411; MF-404
95-1858	20:31009	OSTI; NTIS; INIS; GPO Dep.	E 1.99:	DE95015252	MF-414
95-1886	20:29498	OSTI; NTIS; INIS; GPO Dep.	E 1.99:	DE95015199	MF-714; MF-705
95-1975	20:30237	OSTI; NTIS; GPO Dep.	E 1.99:	DE95017851	MF-901
95-1987	20:29499	OSTI; NTIS; INIS; GPO Dep.	E 1.99:	DE95015260	MF-714; MF-705
95-1988	20:29500	OSTI; NTIS; GPO Dep.	E 1.99:	DE95013094	MF-705
95-2067	20:31068	OSTI; NTIS; INIS; GPO Dep.	E 1.99:	DE95015276	
95-2069	20:29501	OSTI; NTIS; INIS; GPO Dep.	E 1.99:	DE95015306	MF-714; MF-705
95-2084	20:29096	OSTI; NTIS; GPO Dep.	E 1.99:	DE95015301	MF-900
95-2101	20:30954	OSTI; NTIS; INIS; GPO Dep.	E 1.99:	DE95016874	MF-413
95-2127	20:30294	OSTI; NTIS; INIS; GPO Dep.	E 1.99:	DE95016869	MF-714
95-2322	20:30295	OSTI; NTIS; GPO; GPO Dep.	E 1.99:	DE95016786	MF-741
95-2333	20:29983	OSTI; NTIS; GPO Dep.	E 1.99:	DE95016784	MF-900
95-2369	20:30257	OSTI; NTIS; GPO Dep.	E 1.99:	DE95016826	

Report Number	Abstract Number	Source of Availability	GPO Dep.	Order Number	Distribution Category
95-2407	20:30546	OSTI; NTIS; GPO Dep.	E 1.99:	DE95016891	MF-706
95-2408	20:30363	OSTI; NTIS; GPO Dep.	E 1.99:	DE95016890	MF-706
95-2446	20:30892	OSTI; NTIS; GPO Dep.	E 1.99:	DE95016882	MF-705
95-2459	20:31179	OSTI; NTIS; GPO Dep.	E 1.99:	DE95016878	MF-712
95-2461	20:31151	OSTI; NTIS; GPO Dep.	E 1.99:	DE95016914	MF-1423
95-2462	20:29191	OSTI; NTIS; GPO Dep.	E 1.99:	DE95016913	MF-1504
95-2463	20:30870	OSTI; NTIS; GPO Dep.	E 1.99:	DE95016912	MF-1423
95-2465	20:29097	OSTI; NTIS; INIS; GPO Dep.	E 1.99:	DE95016910	MF-2050
95-2484	20:29892	OSTI; NTIS; GPO Dep.	E 1.99:	DE95016994	MF-1502
95-2487	20:29418	OSTI; NTIS; INIS; GPO Dep.	E 1.99:	DE95016996	MF-1241
95-2491	20:30585	OSTI; NTIS; INIS; GPO Dep.	E 1.99:	DE95016997	MF-741
95-2494	20:30296	OSTI; NTIS; INIS; GPO Dep.	E 1.99:	DE96000005	MF-700; MF-707
95-2552	20:30364	OSTI; NTIS; GPO Dep.	E 1.99:	DE95017002	MF-700
95-2590	20:30036	OSTI; NTIS; GPO Dep.	E 1.99:	DE95016979	MF-704
95-2628	20:31121	OSTI; NTIS; GPO Dep.	E 1.99:	DE95016984	MF-705
95-2653	20:30115	OSTI; NTIS; GPO Dep.	E 1.99:	DE95016965	MF-404
95-2657	20:30515	OSTI; NTIS; GPO Dep.	E 1.99:	DE95016966	MF-712
95-2664	20:30893	OSTI; NTIS; GPO Dep.	E 1.99:	DE95016967	MF-910
95-2677	20:29842	OSTI; NTIS; GPO Dep.	E 1.99:	DE96000022	MF-707
95-2694	20:31105	OSTI; NTIS; INIS; GPO Dep.	E 1.99:	DE95016944	MF-700
95-2698	20:29985	OSTI; NTIS; GPO Dep.	E 1.99:	DE95016945	MF-703; MF-700
95-2702	20:29986	OSTI; NTIS; GPO Dep.	E 1.99:	DE95016946	MF-703; MF-700
95-2705	20:30116	OSTI; NTIS; INIS; GPO Dep.	E 1.99:	DE95016947	MF-704
95-2707	20:30722	OSTI; NTIS; GPO Dep.	E 1.99:	DE95016948	MF-906; MF-406
95-2720	20:29941	OSTI; NTIS; GPO Dep.	E 1.99:	DE95016949	MF-705
95-2729	20:30168	OSTI; NTIS; GPO Dep.	E 1.99:	DE95016963	MF-901
95-273	20:30545	OSTI; NTIS; GPO Dep.	E 1.99:	DE95006266	MF-910
95-2746	20:30037	OSTI; NTIS; GPO Dep.	E 1.99:	DE96000017	
95-2764	20:30586	OSTI; NTIS; GPO Dep.	E 1.99:	DE95016937	MF-741
95-2783	20:30894	OSTI; NTIS; GPO Dep.	E 1.99:	DE96000006	MF-402
95-2785	20:30789	OSTI; NTIS; GPO Dep.	E 1.99:	DE96000020	
95-2794	20:30661	OSTI; NTIS; GPO Dep.	E 1.99:	DE95017852	MF-402
95-2815	20:31223	OSTI; NTIS; INIS; GPO Dep.	E 1.99:	DE95016929	MF-706; MF-700
95-2816	20:31224	OSTI; NTIS; INIS; GPO Dep.	E 1.99:	DE95016928	MF-706; MF-700
95-2818	20:30587	OSTI; NTIS; GPO Dep.	E 1.99:	DE95016930	MF-741
95-2819	20:31180	OSTI; NTIS; GPO Dep.	E 1.99:	DE96000007	MF-741
95-2820	20:31181	OSTI; NTIS; INIS; GPO Dep.	E 1.99:	DE96000166	MF-424
95-2826	20:30038	OSTI; NTIS; GPO Dep.	E 1.99:	DE96000008	
95-2833	20:30039	OSTI; NTIS; INIS; GPO Dep.	E 1.99:	DE96000009	MF-404; MF-410
95-2834	20:31122	OSTI; NTIS; GPO Dep.	E 1.99:	DE96000011	MF-410; MF-404
95-2836	20:31349	OSTI; NTIS; GPO Dep.	E 1.99:	DE96000012	
95-2841	20:29990	OSTI; NTIS; GPO Dep.	E 1.99:	DE96000013	MF-906
95-2844	20:30297	OSTI; NTIS; GPO Dep.	E 1.99:	DE96000014	MF-706
95-2853	20:30895	OSTI; NTIS; GPO Dep.	E 1.99:	DE96000015	MF-910
95-2868	20:31225	OSTI; NTIS; GPO Dep.	E 1.99:	DE96000010	MF-910
95-2869	20:30896	OSTI; NTIS; GPO Dep.	E 1.99:	DE96000032	MF-706
95-2875	20:30588	OSTI; NTIS; GPO Dep.	E 1.99:	DE96000001	MF-741
95-2878	20:31107	OSTI; NTIS; GPO Dep.	E 1.99:	DE95016931	MF-910
95-2884	20:30040	OSTI; NTIS; GPO Dep.	E 1.99:	DE96000004	MF-704
95-2888	20:30897	OSTI; NTIS; GPO Dep.	E 1.99:	DE96000003	
95-2894	20:30955	OSTI; NTIS; INIS; GPO Dep.	E 1.99:	DE96000002	MF-414
95-2913	20:30041	OSTI; NTIS; INIS; GPO Dep.	E 1.99:	DE96000041	MF-404
95-2920	20:30042	OSTI; NTIS; GPO Dep.	E 1.99:	DE96000033	MF-704
95-2925	20:31350	OSTI; NTIS; GPO Dep.	E 1.99:	DE96000030	ND-910
95-2927	20:30340	OSTI; NTIS; GPO Dep.	E 1.99:	DE95017559	MF-706
95-2930	20:31182	OSTI; NTIS; INIS; GPO Dep.	E 1.99:	DE96000031	MF-424
95-2937	20:31128	OSTI; NTIS; INIS; GPO Dep.	E 1.99:	DE96000042	MF-910

Report Number	Abstract Number	Source of Availability	GPO Dep.	Order Number	Distribution Category
95-2945	20:31183	OSTI; NTIS; GPO Dep.	E 1.99:	DE96000043	MF-910
95-2954	20:30043	OSTI; NTIS; INIS; GPO Dep.	E 1.99:	DE96000026	MF-404; MF-410
95-2956	20:30589	OSTI; NTIS; GPO Dep.	E 1.99:	DE96000025	MF-741
95-2962	20:30790	OSTI; NTIS; GPO Dep.	E 1.99:	DE96000024	MF-910
95-2969	20:30898	OSTI; NTIS; GPO Dep.	E 1.99:	DE96000023	
95-2971	20:31351	OSTI; NTIS; GPO Dep.	E 1.99:	DE96000021	MF-405
95-2992	20:30044	OSTI; NTIS; INIS; GPO Dep.	E 1.99:	DE96000018	
95-2993	20:31184	OSTI; NTIS; INIS; GPO Dep.	E 1.99:	DE96000028	MF-424
95-3005	20:30899	OSTI; NTIS; GPO Dep.	E 1.99:	DE96000029	MF-910
95-3018	20:30403	OSTI; NTIS; INIS; GPO Dep.	E 1.99:	DE96000039	MF-706
95-3027	20:30117	OSTI; NTIS; INIS; GPO Dep.	E 1.99:	DE96000069	MF-704
95-3035	20:29171	OSTI; NTIS; INIS; GPO Dep.	E 1.99:	DE96000067	MF-706
95-3036	20:30045	OSTI; NTIS; GPO Dep.	E 1.99:	DE96000065	MF-704
95-3046	20:30046	OSTI; NTIS; INIS; GPO Dep.	E 1.99:	DE96000066	MF-404
95-3057	20:30047	OSTI; NTIS; INIS; GPO Dep.	E 1.99:	DE96000072	MF-704
95-3061	20:30454	OSTI; NTIS; INIS; GPO Dep.	E 1.99:	DE96000071	MF-700
95-3091	20:30455	OSTI; NTIS; INIS; GPO Dep.	E 1.99:	DE96000050	MF-700
95-3092	20:30900	OSTI; NTIS; INIS; GPO Dep.	E 1.99:	DE96000049	MF-700
95-3095	20:29981	OSTI; NTIS; INIS; GPO Dep.	E 1.99:	DE96000048	MF-702
95-3102	20:30456	OSTI; NTIS; GPO; GPO Dep.	E 1.99:	DE96000047	MF-700
95-3103	20:28863	OSTI; NTIS; INIS; GPO Dep.	E 1.99:	DE96000046	MF-700
95-3106	20:31185	OSTI; NTIS; INIS; GPO Dep.	E 1.99:	DE96000045	MF-700
95-3125	20:30048	OSTI; NTIS; GPO Dep.	E 1.99:	DE96000070	MF-904; MF-910
95-3126	20:30049	OSTI; NTIS; GPO Dep.	E 1.99:	DE96000038	MF-904; MF-910
95-3127	20:30050	OSTI; NTIS; GPO Dep.	E 1.99:	DE96000034	MF-904
95-3128	20:30901	OSTI; NTIS; GPO Dep.	E 1.99:	DE96000037	
95-3145	20:30051	OSTI; NTIS; GPO Dep.	E 1.99:	DE96000064	MF-704
95-3166	20:30457	OSTI; NTIS; INIS; GPO Dep.	E 1.99:	DE96000036	MF-414
95-3222	20:31352	OSTI; NTIS; INIS; GPO Dep.	E 1.99:	DE96001469	MF-705
95-3297	20:30516	OSTI; NTIS; INIS; GPO Dep.	E 1.99:	DE96001468	MF-905
95-3329	20:31069	OSTI; NTIS; INIS; GPO Dep.	E 1.99:	DE96001470	MF-413
95-3380	20:30204	OSTI; NTIS; GPO Dep.	E 1.99:	DE96001374	MF-900
95-831	20:30584	OSTI; NTIS; GPO Dep.	E 1.99:	DE95007845	
95-855	20:29975	OSTI; NTIS; GPO Dep.	E 1.99:	DE95009432	MF-706
95-906	20:31342	OSTI; NTIS; GPO Dep.	E 1.99:	DE95009427	MF-705
95-994	20:31343	OSTI; NTIS; GPO Dep.	E 1.99:	DE95009415	MF-705
LAMP–					
95/4	20:30817	OSTI; NTIS (US Sales Only); INIS		DE96601837	
95/5	20:30888	OSTI; NTIS (US Sales Only); INIS		DE96602172	
LBL–					
27170(1995)	20:28890	OSTI; NTIS; INIS; GPO Dep.	E 1.99:	DE96001003	MF-600
31248-Rev.	20:30605	OSTI; NTIS; GPO Dep.	E 1.99:	DE96001004	MF-421
33934	20:29908	OSTI; NTIS; GPO Dep.	E 1.99:	DE95014785	MF-1600
34772-Rev.	20:29782	OSTI; NTIS; GPO Dep.	E 1.99:	DE96000872	MF-1321
35470	20:30170	OSTI; NTIS; GPO Dep.	E 1.99:	DE96000127	MF-411
35550	20:30463	OSTI; NTIS; INIS; GPO Dep.	E 1.99:	DE96001115	MF-414
35642	20:29843	OSTI; NTIS; GPO Dep.	E 1.99:	DE95016423	MF-1600
35738	20:30723	OSTI; NTIS; GPO Dep.	E 1.99:	DE96000873	MF-405
36166	20:30118	OSTI; NTIS; GPO Dep.	E 1.99:	DE96001122	MF-400; MF-1600
36235	20:28891	OSTI; NTIS (documentation only); ESTSC (complete software package), P.O. Box 1020, Oak Ridge, TN 37831-1020 (United States); GPO Dep.	E 1.99:	DE96000874	MF-814; MF-1240
36247	20:31353	OSTI; NTIS; GPO Dep.	E 1.99:	DE95006575	MF-400
36342	20:30464	OSTI; NTIS; INIS; GPO Dep.	E 1.99:	DE96001105	MF-414
36434	20:30493	OSTI; NTIS; GPO Dep.	E 1.99:	DE96001108	MF-410
36435	20:30426	OSTI; NTIS; INIS; GPO Dep.	E 1.99:	DE96001308	MF-410
36440	20:30427	OSTI; NTIS; GPO Dep.	E 1.99:	DE96000143	MF-410
36442	20:30465	OSTI; NTIS; GPO Dep.	E 1.99:	DE96001107	MF-410
36443	20:30428	OSTI; NTIS; INIS; GPO Dep.	E 1.99:	DE96001309	MF-410
36444	20:30466	OSTI; NTIS; GPO Dep.	E 1.99:	DE95014798	MF-410
36458	20:30429	OSTI; NTIS; INIS; GPO Dep.	E 1.99:	DE96000132	MF-414
36527	20:28892	OSTI; NTIS; INIS; GPO Dep.	E 1.99:	DE95016455	MF-814

Report Number	Abstract Number	Source of Availability	GPO Dep.	Order Number	Distribution Category
36538	20:30467	OSTI; NTIS; INIS; GPO Dep.	E 1.99:	DE96001307	MF-410
36540	20:31354	OSTI; NTIS; GPO Dep.	E 1.99:	DE96000144	MF-405; MF-406
36541	20:31227	OSTI; NTIS; INIS; GPO Dep.	E 1.99:	DE95014794	MF-419
36542	20:31228	OSTI; NTIS; INIS; GPO Dep.	E 1.99:	DE96000133	MF-414
36561	20:30468	OSTI; NTIS; INIS; GPO Dep.	E 1.99:	DE96001306	MF-410
36562	20:30469	OSTI; NTIS; GPO Dep.	E 1.99:	DE96001106	MF-410
36576	20:30430	OSTI; NTIS; GPO Dep.	E 1.99:	DE96000142	MF-406
36603	20:29909	OSTI; NTIS; GPO Dep.	E 1.99:	DE96000875	MF-1322
36620	20:30470	OSTI; NTIS; INIS; GPO Dep.	E 1.99:	DE96001305	MF-410
36622	20:31229	OSTI; NTIS; INIS; GPO Dep.	E 1.99:	DE96000117	MF-414
36636	20:29910	OSTI; NTIS; GPO Dep.	E 1.99:	DE95014789	MF-1600
36645	20:29172	OSTI; NTIS; GPO Dep.	E 1.99:	DE96001124	MF-406
36647	20:29956	OSTI; NTIS; GPO Dep.	E 1.99:	DE96000128	MF-1322
36658	20:29911	OSTI; NTIS; GPO Dep.	E 1.99:	DE95016456	MF-1600
36739	20:29098	OSTI; NTIS; INIS; GPO Dep.	E 1.99:	DE96000134	MF-2010
36775	20:31355	OSTI; NTIS; GPO Dep.	E 1.99:	DE96000131	MF-2070
36782	20:29813	OSTI; NTIS; GPO Dep.	E 1.99:	DE96001111	MF-406
36783	20:30055	OSTI; NTIS; INIS; GPO Dep.	E 1.99:	DE96000124	MF-426
36875	20:30238	OSTI; NTIS; INIS; GPO Dep.	E 1.99:	DE96000126	MF-404
36975	20:29912	OSTI; NTIS; GPO Dep.	E 1.99:	DE95014784	MF-1600
37032-Rev.	20:30299	OSTI; NTIS; GPO Dep.	E 1.99:	DE96000876	MF-405
37082	20:30517	OSTI; NTIS; INIS; GPO Dep.	E 1.99:	DE95014795	MF-414
37091	20:30119	OSTI; NTIS; GPO Dep.	E 1.99:	DE96000119	MF-114
37120	20:31082	OSTI; NTIS; INIS; GPO Dep.	E 1.99:	DE95014830	MF-414
37121	20:31083	OSTI; NTIS; INIS; GPO Dep.	E 1.99:	DE95014831	MF-413
37141	20:30488	*See* UCRL-JC–119360			
37147	20:30365	OSTI; NTIS; INIS; GPO Dep.	E 1.99:	DE96000189	MF-404
37151	20:30366	OSTI; NTIS; GPO Dep.	E 1.99:	DE96000145	MF-410
37157-Vol.2	20:29877	OSTI; NTIS; GPO Dep.	E 1.99:	DE96001013	MF-1321
37159	20:29913	OSTI; NTIS; GPO Dep.	E 1.99:	DE96001113	MF-400
37193	20:30804	OSTI; NTIS; INIS; GPO Dep.	E 1.99:	DE96000118	MF-406
37231	20:30400	OSTI; NTIS; INIS; GPO Dep.	E 1.99:	DE96000147	MF-411
37243	20:30518	OSTI; NTIS; INIS; GPO Dep.	E 1.99:	DE96001120	MF-414
37244	20:31010	OSTI; NTIS; INIS; GPO Dep.	E 1.99:	DE95014791	MF-414
37249	20:30367	OSTI; NTIS; GPO Dep.	E 1.99:	DE96000135	MF-404
37267	20:30368	OSTI; NTIS; GPO Dep.	E 1.99:	DE95016465	MF-404
37272	20:31108	OSTI; NTIS; GPO Dep.	E 1.99:	DE95014796	MF-401
37301	20:30412	OSTI; NTIS; INIS; GPO Dep.	E 1.99:	DE96000129	MF-414
37307	20:30494	OSTI; NTIS; INIS; GPO Dep.	E 1.99:	DE96001310	MF-414
37309	20:30205	OSTI; NTIS; GPO Dep.	E 1.99:	DE96000111	MF-401
37310	20:30519	OSTI; NTIS; INIS; GPO Dep.	E 1.99:	DE96001117	MF-406
37311	20:30471	OSTI; NTIS; INIS; GPO Dep.	E 1.99:	DE96000123	MF-413
37315	20:30862	OSTI; NTIS; GPO Dep.	E 1.99:	DE96000121	MF-414
37340	20:30431	OSTI; NTIS; GPO Dep.	E 1.99:	DE96000146	MF-405; MF-406
37356	20:30850	OSTI; NTIS; INIS; GPO Dep.	E 1.99:	DE96000149	MF-814
37389	20:30902	OSTI; NTIS; INIS; GPO Dep.	E 1.99:	DE96000122	MF-410
37402	20:30805	OSTI; NTIS; GPO Dep.	E 1.99:	DE96000120	MF-405
37425	20:30990	OSTI; NTIS; INIS; GPO Dep.	E 1.99:	DE96000140	MF-414
37439-Rev.	20:30871	OSTI; NTIS; GPO Dep.	E 1.99:	DE96001016	MF-401
37449	20:30120	OSTI; NTIS; GPO Dep.	E 1.99:	DE96000113	MF-401
37477	20:30737	OSTI; NTIS; GPO Dep.	E 1.99:	DE96000112	MF-402
37481	20:30171	OSTI; NTIS; GPO Dep.	E 1.99:	DE96000136	MF-404
37487	20:30121	OSTI; NTIS; GPO Dep.	E 1.99:	DE95017558	MF-114
37492	20:28900	OSTI; NTIS; INIS; GPO Dep.	E 1.99:	DE96001002	MF-814
37505	20:30300	OSTI; NTIS; GPO Dep.	E 1.99:	DE96001101	MF-405
37507	20:31011	OSTI; NTIS; INIS; GPO Dep.	E 1.99:	DE96000130	MF-414
37525	20:30172	OSTI; NTIS; GPO Dep.	E 1.99:	DE96001112	MF-404
37532	20:31030	OSTI; NTIS; INIS; GPO Dep.	E 1.99:	DE96001118	MF-414; MF-412
37533	20:30239	OSTI; NTIS; GPO Dep.	E 1.99:	DE96001060	MF-401
37536	20:30547	OSTI; NTIS; GPO Dep.	E 1.99:	DE96001114	MF-404

Report Number	Abstract Number	Source of Availability	GPO Dep.	Order Number	Distribution Category
37540	20:30250	OSTI; NTIS; GPO Dep.	E 1.99:	DE96000114	MF-401
37545	20:31109	OSTI; NTIS; INIS; GPO Dep.	E 1.99:	DE96001116	MF-411
37554	20:30738	OSTI; NTIS; INIS; GPO Dep.	E 1.99:	DE96001123	MF-2010
37556	20:29173	OSTI; NTIS; INIS; GPO Dep.	E 1.99:	DE96001014	MF-414
37565	20:30956	OSTI; NTIS; INIS; GPO Dep.	E 1.99:	DE96001059	MF-414
37582	20:30520	OSTI; NTIS; INIS; GPO Dep.	E 1.99:	DE96000116	MF-404
37586	20:30173	OSTI; NTIS; GPO Dep.	E 1.99:	DE96000125	MF-404
37588	20:31102	OSTI; NTIS; GPO Dep.	E 1.99:	DE96000115	MF-401
37591	20:30174	OSTI; NTIS; GPO Dep.	E 1.99:	DE96001075	MF-404
37611	20:29412	OSTI; NTIS; GPO Dep.	E 1.99:	DE96001121	MF-1240
37630	20:30495	OSTI; NTIS; GPO Dep.	E 1.99:	DE96001104	MF-410
37640	20:30056	OSTI; NTIS; GPO Dep.	E 1.99:	DE96001119	MF-410
37646	20:30240	OSTI; NTIS; INIS; GPO Dep.	E 1.99:	DE96001061	MF-401
37657	20:30472	OSTI; NTIS; INIS; GPO Dep.	E 1.99:	DE96001304	MF-410
37749	20:30806	OSTI; NTIS; GPO Dep.	E 1.99:	DE96001015	MF-405
LBL-PUB–					
3123-Rev.1	20:29852	OSTI; NTIS; GPO Dep.	E 1.99:	DE96000141	MF-400
LNS–					
177	20:31129	OSTI; NTIS; INIS		DE96602924	
LRC–					
95-48	20:31158	*See* DOE/ER/54169–T1			
LRP–					
522/95	20:31186	OSTI; NTIS; INIS		DE96602359	
523/95	20:31187	OSTI; NTIS; INIS		DE96602360	
LS–					
114	20:30432	OSTI; NTIS; GPO Dep.	E 1.99:	DE95015556	MF-411
157	20:30433	OSTI; NTIS; GPO Dep.	E 1.99:	DE95015553	MF-411
174(ANL)	20:30496	OSTI; NTIS; INIS; GPO Dep.	E 1.99:	DE95015544	MF-411
175	20:30497	OSTI; NTIS; INIS; GPO Dep.	E 1.99:	DE95015573	MF-414
176	20:30473	OSTI; NTIS; GPO Dep.	E 1.99:	DE95015496	MF-411
179	20:30434	OSTI; NTIS; GPO Dep.	E 1.99:	DE95015498	MF-411
188	20:30474	OSTI; NTIS; INIS; GPO Dep.	E 1.99:	DE95015202	MF-414; MF-411
244	20:30475	OSTI; NTIS; INIS; GPO Dep.	E 1.99:	DE95015830	MF-414; MF-411
LSBL–					
276	20:30056	*See* LBL–37640			
277	20:30472	*See* LBL–37657			
LSGN–					
195	20:30427	*See* LBL–36440			
206	20:30366	*See* LBL–37151			
213	20:30430	*See* LBL–36576			
214	20:31354	*See* LBL–36540			
215	20:30468	*See* LBL–36561			
216	20:30431	*See* LBL–37340			
MISU-IMI-CM–					
85	20:30664	OSTI; NTIS		DE96703706	
MLM–					
103	20:30253	OSTI; NTIS; GPO Dep.	E 1.99:	DE96001403	MF-700
104	20:30301	OSTI; NTIS; GPO Dep.	E 1.99:	DE96001399	MF-700
105	20:30206	OSTI; NTIS; GPO Dep.	E 1.99:	DE96001404	MF-700
108	20:30563	OSTI; NTIS; GPO Dep.	E 1.99:	DE96000789	MF-706
109	20:30207	OSTI; NTIS; GPO Dep.	E 1.99:	DE96001400	MF-700
11	20:29174	OSTI; NTIS; GPO Dep.	E 1.99:	DE96001486	MF-700
113	20:30254	OSTI; NTIS; GPO Dep.	E 1.99:	DE96001405	MF-700
114	20:30255	OSTI; NTIS; GPO Dep.	E 1.99:	DE96001406	MF-700
122	20:30208	OSTI; NTIS; GPO Dep.	E 1.99:	DE96001401	MF-700
124	20:29176	OSTI; NTIS; GPO Dep.	E 1.99:	DE96001421	MF-700
131	20:30607	OSTI; NTIS; GPO Dep.	E 1.99:	DE96001471	MF-701
132	20:30608	OSTI; NTIS; GPO Dep.	E 1.99:	DE96001472	MF-700
133	20:30609	OSTI; NTIS; GPO Dep.	E 1.99:	DE96001473	MF-701
138	20:30610	OSTI; NTIS; GPO Dep.	E 1.99:	DE96001474	MF-700
146	20:30209	OSTI; NTIS; GPO Dep.	E 1.99:	DE96000801	MF-700
155	20:30611	OSTI; NTIS; GPO Dep.	E 1.99:	DE96001476	MF-700
158	20:30256	OSTI; NTIS; GPO Dep.	E 1.99:	DE96001424	MF-700
159	20:30612	OSTI; NTIS; GPO Dep.	E 1.99:	DE96001477	MF-700
162	20:30210	OSTI; NTIS; GPO Dep.	E 1.99:	DE96001402	MF-600
168	20:30248	OSTI; NTIS; GPO Dep.	E 1.99:	DE96001425	MF-700
170	20:30211	OSTI; NTIS; GPO Dep.	E 1.99:	DE96001426	MF-700

Report Number	Abstract Number	Source of Availability	GPO Dep.	Order Number	Distribution Category
172	20:29183	OSTI; NTIS; GPO Dep.	E 1.99:	DE96001427	MF-700
173	20:29161	OSTI; NTIS; GPO Dep.	E 1.99:	DE96001428	MF-700
174	20:29162	OSTI; NTIS; GPO Dep.	E 1.99:	DE96001429	MF-700
175	20:30242	OSTI; NTIS; GPO Dep.	E 1.99:	DE96001430	MF-700
176	20:30613	OSTI; NTIS; GPO Dep.	E 1.99:	DE96001479	MF-700
178	20:29177	OSTI; NTIS; GPO Dep.	E 1.99:	DE96001431	MF-700
193	20:30057	OSTI; NTIS; GPO Dep.	E 1.99:	DE96001481	MF-701; MF-706
200	20:29178	OSTI; NTIS; GPO Dep.	E 1.99:	DE96001445	MF-700
204	20:29163	OSTI; NTIS; GPO Dep.	E 1.99:	DE96001448	MF-700
213	20:30058	OSTI; NTIS; GPO Dep.	E 1.99:	DE96001505	MF-700
218	20:30614	OSTI; NTIS; GPO Dep.	E 1.99:	DE96001398	MF-700
220	20:29164	OSTI; NTIS; GPO Dep.	E 1.99:	DE96001508	MF-700
2240(LD)	20:28902	OSTI; NTIS; GPO Dep.	E 1.99:	DE96000799	MF-721
23	20:29156	OSTI; NTIS; GPO Dep.	E 1.99:	DE96001488	MF-700
236	20:29165	OSTI; NTIS; GPO Dep.	E 1.99:	DE96001515	MF-700
242	20:29179	OSTI; NTIS; GPO Dep.	E 1.99:	DE96001517	MF-700
251	20:29166	OSTI; NTIS; GPO Dep.	E 1.99:	DE96001521	MF-700
26	20:30246	OSTI; NTIS; GPO Dep.	E 1.99:	DE96001500	MF-701
276	20:30059	OSTI; NTIS; GPO Dep.	E 1.99:	DE96001528	MF-700
277	20:28901	OSTI; NTIS; GPO Dep.	E 1.99:	DE96001529	MF-700
282	20:30060	OSTI; NTIS; GPO Dep.	E 1.99:	DE96001531	MF-704
283	20:30522	OSTI; NTIS; GPO Dep.	E 1.99:	DE96001596	MF-700
285	20:30302	OSTI; NTIS; GPO Dep.	E 1.99:	DE96001396	MF-700
295	20:30061	OSTI; NTIS; GPO Dep.	E 1.99:	DE96001593	MF-704
3676	20:29132	OSTI; NTIS; GPO Dep.	E 1.99:	DE96000791	MF-700
61	20:29157	OSTI; NTIS; GPO Dep.	E 1.99:	DE96001489	MF-721
63	20:30241	OSTI; NTIS; GPO Dep.	E 1.99:	DE96001490	MF-700
66	20:29158	OSTI; NTIS; GPO Dep.	E 1.99:	DE96001492	MF-700
72	20:29159	OSTI; NTIS; GPO Dep.	E 1.99:	DE96001493	MF-721
74	20:30521	OSTI; NTIS; GPO Dep.	E 1.99:	DE96001482	MF-706; MF-704
75	20:30247	OSTI; NTIS; GPO Dep.	E 1.99:	DE96001494	MF-700
85	20:29160	OSTI; NTIS; GPO Dep.	E 1.99:	DE96001496	MF-700
92	20:29175	OSTI; NTIS; GPO Dep.	E 1.99:	DE96001498	MF-700
97	20:28764	OSTI; NTIS; GPO Dep.	E 1.99:	DE96001485	MF-706
98	20:30606	OSTI; NTIS; GPO Dep.	E 1.99:	DE96001499	MF-700
MLM-MU–					
89-62-0003	20:30303	OSTI; NTIS; GPO Dep.	E 1.99:	DE96001395	MF-700
89-62-0004	20:29787	OSTI; NTIS; GPO Dep.	E 1.99:	DE96000802	MF-706
89-62-0007	20:29099	OSTI; NTIS; GPO Dep.	E 1.99:	DE96000797	MF-702
89-63-0001	20:30739	OSTI; NTIS; GPO Dep.	E 1.99:	DE96000798	MF-702
89-63-0002	20:29133	OSTI; NTIS; GPO Dep.	E 1.99:	DE96000795	MF-706
89-63-0006	20:29100	OSTI; NTIS; GPO Dep.	E 1.99:	DE96000793	MF-707
89-64-0008	20:30304	OSTI; NTIS; GPO Dep.	E 1.99:	DE96000800	MF-700
89-64-0012	20:30740	OSTI; NTIS; GPO Dep.	E 1.99:	DE96000796	MF-702
89-64-0013	20:30305	OSTI; NTIS; GPO Dep.	E 1.99:	DE96000792	MF-706
MRC/ABQ-R–					
1686	20:30451	*See* LA-SUB–95-102			
NDP–					
051	20:30772	*See* BNL–62026			
NEDO-IT–					
9301	20:31362	OSTI; NTIS; Available from New Energy and Industrial Technology Development Organization, Sunshine 60, 30F 1-1, 3-chome, Higashi-Ikebukuro, Toshima-ku, Tokyo, Japan		DE96704375	
9302	20:29893	OSTI; NTIS; Available from New Energy and Industrial Technology Development Organization, Sunshine 60, 30F 1-1, 3-chome, Higashi-Ikebukuro, Toshima-ku, Tokyo, Japan		DE96704376	
9303	20:30791	OSTI; NTIS; Available from New Energy and Industrial Technology Development Organization, Sunshine 60, 30F 1-1, 3-chome, Higashi-Ikebukuro, Toshima-ku, Tokyo, Japan		DE96704377	
9304	20:30369	OSTI; NTIS; Available from New Energy and Industrial Technology Development Organization, Sunshine 60, 30F 1-1, 3-chome, Higashi-Ikebukuro, Toshima-ku, Tokyo, Japan		DE96704378	
9305	20:30792	OSTI; NTIS; Available from New Energy and Industrial Technology Development Organization, Sunshine 60, 30F 1-1, 3-chome, Higashi-Ikebukuro, Toshima-ku, Tokyo, Japan		DE96704379	

Report Number	Abstract Number	Source of Availability	GPO Dep.	Order Number	Distribution Category
9306	20:29192	OSTI; NTIS; Available from New Energy and Industrial Technology Development Organization, Sunshine 60, 30F 1-1, 3-chome, Higashi-Ikebukuro, Toshima-ku, Tokyo, Japan		DE96704380	
9307	20:30903	OSTI; NTIS; Available from New Energy and Industrial Technology Development Organization, Sunshine 60, 30F 1-1, 3-chome, Higashi-Ikebukuro, Toshima-ku, Tokyo, Japan		DE96704381	
9308-Pt.1	20:31405	OSTI; NTIS; Available from New Energy and Industrial Technology Development Organization, Sunshine 60, 30F 1-1, 3-chome, Higashi-Ikebukuro, Toshima-ku, Tokyo, Japan		DE96704382	
9308-Pt.2	20:31406	OSTI; NTIS; Available from New Energy and Industrial Technology Development Organization, Sunshine 60, 30F 1-1, 3-chome, Higashi-Ikebukuro, Toshima-ku, Tokyo, Japan		DE96704383	
9309	20:29824	OSTI; NTIS; Available from New Energy and Industrial Technology Development Organization, Sunshine 60, 30F 1-1, 3-chome, Higashi-Ikebukuro, Toshima-ku, Tokyo, Japan		DE96704384	
NEDO-P–					
9402	20:29844	OSTI; NTIS; Available from New Energy and Industrial Technology Development Organization, Sunshine 60, 30F 1-1, 3-chome, Higashi-Ikebukuro, Toshima-ku, Tokyo, Japan		DE96704385	
9407	20:29869	OSTI; NTIS; Available from New Energy and Industrial Technology Development Organization, Sunshine 60, 30F 1-1, 3-chome, Higashi-Ikebukuro, Toshima-ku, Tokyo, Japan		DE96704386	
9408	20:29818	OSTI; NTIS; Available from New Energy and Industrial Technology Development Organization, Sunshine 60, 30F 1-1, 3-chome, Higashi-Ikebukuro, Toshima-ku, Tokyo, Japan		DE96704387	
9409	20:29882	OSTI; NTIS; Available from New Energy and Industrial Technology Development Organization, Sunshine 60, 30F 1-1, 3-chome, Higashi-Ikebukuro, Toshima-ku, Tokyo, Japan		DE96704388	
9415	20:29437	OSTI; NTIS; Available from New Energy and Industrial Technology Development Organization, Sunshine 60, 30F 1-1, 3-chome, Higashi-Ikebukuro, Toshima-ku, Tokyo, Japan		DE96704401	
9424	20:29894	OSTI; NTIS; Available from New Energy and Industrial Technology Development Organization, Sunshine 60, 30F 1-1, 3-chome, Higashi-Ikebukuro, Toshima-ku, Tokyo, Japan		DE96704389	
9426	20:29398	OSTI; NTIS; Available from New Energy and Industrial Technology Development Organization, Sunshine 60, 30F 1-1, 3-chome, Higashi-Ikebukuro, Toshima-ku, Tokyo, Japan		DE96704391	
9427	20:29399	OSTI; NTIS; Available from New Energy and Industrial Technology Development Organization, Sunshine 60, 30F 1-1, 3-chome, Higashi-Ikebukuro, Toshima-ku, Tokyo, Japan		DE96704390	
9434	20:29870	OSTI; NTIS; Available from New Energy and Industrial Technology Development Organization, Sunshine 60, 30F 1-1, 3-chome, Higashi-Ikebukuro, Toshima-ku, Tokyo, Japan		DE96704392	
9460	20:29883	OSTI; NTIS; Available from New Energy and Industrial Technology Development Organization, Sunshine 60, 30F 1-1, 3-chome, Higashi-Ikebukuro, Toshima-ku, Tokyo, Japan		DE96704393	
NEI-NO–					
575	20:30243	OSTI; NTIS		DE96703732	
576	20:28685	OSTI; NTIS		DE96703731	
577	20:28686	OSTI; NTIS		DE96703730	
578	20:28687	OSTI; NTIS		DE96703729	
579	20:30665	OSTI; NTIS		DE96703728	
NIF-LLNL–					
94-113-Vol.1	20:31286	*See* UCRL-PROP–117093-Vol.1			
NIFS–					
341	20:31363	OSTI; NTIS; INIS		DE96701294	

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NIFS-DATA–					
25	20:31188	OSTI; NTIS; INIS		DE96701328	
NIFS-PROC–					
24	20:30872	OSTI; NTIS; INIS		DE96701437	
NIPER/BDM–					
0074	20:28703	OSTI; NTIS; GPO Dep.	E 1.99:	DE95000183	PC-122
NISTIR–					
5013	20:31230	OSTI; NTIS; INIS; GPO Dep.	E 1.99:	DE95015476	MF-420
NREL/TP–					
411-8122	20:29394	OSTI; NTIS; GPO Dep.	E 1.99:	DE95009273	MF-1262
425-6969	20:29978	OSTI; NTIS; GPO Dep.	E 1.99:	DE95009233	MF-1504
425-7619	20:29979	OSTI; NTIS; GPO Dep.	E 1.99:	DE95013115	MF-1504
442-6912	20:29424	OSTI; NTIS; GPO Dep.	E 1.99:	DE95009264	MF-1211
442-7391	20:29425	OSTI; NTIS; GPO Dep.	E 1.99:	DE95009291	MF-1211
442-8108	20:29395	OSTI; NTIS; GPO Dep.	E 1.99:	DE95009242	MF-1262
NUREG–					
0090-Vol.17-No.4	20:29592	OSTI; NTIS; INIS; GPO		TI95015579	
0304-Vol.20-No.2	20:29497	OSTI; NTIS; INIS; GPO		TI96000830	
0540	20:31297	OSTI; NTIS; INIS; GPO		TI96000241	
0750-Vol.41-Index2	20:29490	OSTI; NTIS; INIS; GPO		TI96000826	
0750-Vol.41-No.6	20:29491	OSTI; NTIS; INIS; GPO		TI95017055	
0936	20:29865	OSTI; NTIS; INIS; GPO		TI96000242	
0980-Vol.1-No.3	20:29872	OSTI; NTIS; INIS; GPO		TI96001434	
0980-Vol.2-No.3	20:29873	OSTI; NTIS; INIS; GPO		TI96001435	
1122-Rev.1	20:29469	OSTI; NTIS; INIS; GPO		TI96000825	
1123-Rev.1	20:29459	OSTI; NTIS; INIS; GPO		TI95017799	
NUREG/CP–					
0148	20:29771	OSTI; NTIS; INIS; GPO		TI96000695	
NUREG/CR–					
4667	20:29516	OSTI; NTIS; INIS; GPO		TI96000165	
5535-Vol.1	20:29772	OSTI; NTIS; INIS; GPO		TI95017607	
5535-Vol.4	20:29773	OSTI; NTIS; INIS; GPO		TI95017605	
6002	20:29774	OSTI; NTIS; INIS; GPO		TI96000194	
6017	20:29775	OSTI; NTIS; INIS; GPO		TI96001168	
6100	20:29517	OSTI; INIS; GPO; NTIS		TI96000305	
6159	20:29527	OSTI; NTIS; INIS; GPO		TI96000293	
6265	20:29776	OSTI; NTIS; INIS; GPO		TI95017660	
6305	20:28905	OSTI; NTIS; INIS; GPO		TI95017659	
6323	20:30807	OSTI; NTIS; INIS; GPO		TI96000406	
6324	20:29186	OSTI; NTIS; INIS; GPO		TI96000407	
6356	20:28906	OSTI; NTIS; INIS; GPO		TI95017371	
NYSERDA–					
95-11	20:29976	OSTI; New York State Energy Research and Development Authority, Two Empire State Plaza, Suite 1901, Albany, NY 12223-1253 (United States); New York State Energy Research and Development Authority, 2 Empire State Plaza, Suite 1901, Albany, NY 12223-1253 (United States). Phone: 518-465-6251, extension 241.		TI95017409	
95-12	20:29350	OSTI; NTIS; GPO Dep.	E 1.99:	DE95017408	
96000321	20:29914	OSTI; New York State Energy Research and Development Authority, Two Empire State Plaza, Suite 1901, Albany, NY 12223-1253 (United States)		TI96000321	
OCDO–					
96000306	20:28657	OSTI; Ohio Coal Development Office, 77 S. High Street, P.O. Box 1001, Columbus, OH 43266-0001 (United States)		TI96000306	
ORAU–					
95/F-29	20:30831	OSTI; NTIS; INIS; GPO Dep.	E 1.99:	DE96001360	MF-908
ORNL–					
6764	20:30625	OSTI; NTIS; GPO Dep.	E 1.99:	DE96000884	

Report Number	Abstract Number	Source of Availability	GPO Dep.	Order Number	Distribution Category
6827	20:29400	OSTI; NTIS; GPO Dep.	E 1.99:	DE96000882	MF-1210; MF-1250; MF-1300
6854	20:28907	OSTI; NTIS; INIS; GPO Dep.	E 1.99:	DE96000899	MF-2030
6876	20:29853	OSTI; NTIS; GPO Dep.	E 1.99:	DE96000900	PC-401
ORNL/CDIAC–					
82	20:30772	*See* BNL–62026			
84	20:30775	OSTI; NTIS; GPO Dep.	E 1.99:	DE96001357	MF-402
ORNL/CON–					
389	20:29915	OSTI; NTIS; GPO Dep.	E 1.99:	DE96000196	MF-1425
ORNL/ER–					
183/A1	20:28908	OSTI; NTIS; INIS; GPO Dep.	E 1.99:	DE95017188	MF-2070
297	20:28909	OSTI; NTIS; INIS; GPO Dep.	E 1.99:	DE95017059	MF-2030
304	20:28910	OSTI; NTIS; INIS; GPO Dep.	E 1.99:	DE95016172	MF-2020
306	20:28911	OSTI; NTIS; INIS; GPO Dep.	E 1.99:	DE95017049	MF-2030
307	20:28912	OSTI; NTIS; INIS; GPO Dep.	E 1.99:	DE95017047	MF-2070
312	20:28913	OSTI; NTIS; INIS; GPO Dep.	E 1.99:	DE95016167	MF-2020
325	20:29101	OSTI; NTIS; INIS; GPO Dep.	E 1.99:	DE95017060	MF-2050
329/V1	20:28914	OSTI; NTIS; INIS; GPO Dep.	E 1.99:	DE95017189	MF-2070
329/V2	20:28915	OSTI; NTIS; INIS; GPO Dep.	E 1.99:	DE95017190	MF-2070
ORNL/FMP–					
95/1	20:29991	OSTI; NTIS; GPO Dep.	E 1.99:	DE96001412	MF-114
ORNL/M–					
1676	20:29916	OSTI; NTIS; GPO Dep.	E 1.99:	DE96000686	MF-1425
4079	20:30124	OSTI; NTIS; GPO Dep.	E 1.99:	DE96000761	MF-1425
4227	20:29854	OSTI; NTIS; GPO Dep.	E 1.99:	DE96000847	MF-402
4306	20:29572	OSTI; NTIS; INIS; GPO Dep.	E 1.99:	DE95017187	MF-413
4322	20:28916	OSTI; NTIS; INIS; GPO Dep.	E 1.99:	DE96000835	MF-714
4324	20:29573	OSTI; NTIS; INIS; GPO Dep.	E 1.99:	DE96000837	MF-413
ORNL/SUB–					
86-97393/6	20:28780	OSTI; NTIS; INIS; GPO Dep.	E 1.99:	DE96001001	MF-840
86-97393/8	20:28781	OSTI; NTIS; INIS; GPO Dep.	E 1.99:	DE96000775	MF-840
ORNL/Sub–					
85-27421/07	20:30068	OSTI; NTIS; GPO Dep.	E 1.99:	DE95017710	MF-114
94-SS109/01	20:30121	*See* LBL–37487			
ORNL/TM–					
11210	20:30741	OSTI; NTIS; GPO Dep.	E 1.99:	DE96000883	
11601	20:29965	OSTI; NTIS; INIS; GPO Dep.	E 1.99:	DE95017849	MF-602
12299	20:28917	OSTI; NTIS; INIS; GPO Dep.	E 1.99:	DE96000849	MF-2020
12811	20:31364	OSTI; NTIS; GPO Dep.	E 1.99:	DE95017198	MF-405
12851	20:29102	OSTI; NTIS; INIS; GPO Dep.	E 1.99:	DE96000848	MF-2010
12924	20:30125	OSTI; NTIS; GPO Dep.	E 1.99:	DE96000294	MF-1505
12944	20:30069	OSTI; NTIS; GPO Dep.	E 1.99:	DE96000850	MF-114; MF-103; MF-109
12986	20:31365	OSTI; NTIS; GPO Dep.	E 1.99:	DE95017310	MF-405
12999	20:31366	OSTI; NTIS; GPO Dep.	E 1.99:	DE95017191	
13005	20:29574	OSTI; NTIS; INIS; GPO Dep.	E 1.99:	DE95017192	MF-2000
13009	20:31234	OSTI; NTIS; INIS; GPO Dep.	E 1.99:	DE96000177	PC-426
13015	20:28918	OSTI; NTIS; INIS; GPO Dep.	E 1.99:	DE96000851	MF-402
13027	20:30569	OSTI; NTIS; GPO Dep.	E 1.99:	DE95016385	

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13032	20:30742	OSTI; NTIS; GPO Dep.	E 1.99:	DE96000853	
13039	20:29031	OSTI; NTIS; GPO Dep.	E 1.99:	DE95017311	MF-511
13050	20:29922	OSTI; NTIS; GPO Dep.	E 1.99:	DE96000845	
13051	20:30743	OSTI; NTIS; GPO Dep.	E 1.99:	DE96000833	MF-2000
13055	20:31407	OSTI; NTIS; INIS; GPO Dep.	E 1.99:	DE96000315	MF-2000
13060	20:31367	OSTI; NTIS; GPO Dep.	E 1.99:	DE96000838	MF-405; MF-905
13071	20:30776	OSTI; NTIS; GPO Dep.	E 1.99:	DE96000832	MF-1310
13074	20:31190	OSTI; NTIS; INIS; GPO Dep.	E 1.99:	DE96001018	PC-427
13078	20:28919	OSTI; NTIS; INIS; GPO Dep.	E 1.99:	DE96000834	MF-2030
OSU-NE–					
9304	20:29487	*See* DOE/ER/12901–T1			
OZ–					
94/07	20:31032	*See* UM-P–94/20			
94/12	20:31033	*See* UM-P–94/25			
PATENTS-US–					
A8066398	20:28920	OSTI; NTIS (US Sales Only); GPO Dep.	E 1.99:	DE95016427	MF-406
A8075900	20:30308	OSTI; NTIS (US Sales Only); GPO Dep.	E 1.99:	DE95017109	MF-706
A8076060	20:28634	OSTI; NTIS (US Sales Only); GPO Dep.	E 1.99:	DE95017110	MF-106
PITHA–					
94/17	20:31033	*See* UM-P–94/25			
PNC-TN–					
1100-94-002	20:28921	OSTI; NTIS; INIS		DE96701392	
PNL–					
10213	20:28926	OSTI; NTIS; INIS; GPO Dep.	E 1.99:	DE95017064	MF-2030
10363	20:29103	OSTI; NTIS; INIS; GPO Dep.	E 1.99:	DE96000715	MF-2000
10388	20:28927	OSTI; NTIS; INIS; GPO Dep.	E 1.99:	DE95015771	MF-2070
10505	20:28928	OSTI; NTIS; INIS; GPO Dep.	E 1.99:	DE95015445	MF-2070
10510	20:28929	OSTI; NTIS; INIS; GPO Dep.	E 1.99:	DE96000871	MF-2000
10575	20:30668	OSTI; NTIS; INIS; GPO Dep.	E 1.99:	DE96001151	MF-2000
10587	20:28930	OSTI; NTIS; INIS; GPO Dep.	E 1.99:	DE96001138	MF-2030
10601	20:29104	OSTI; NTIS; INIS; GPO Dep.	E 1.99:	DE96000877	MF-2000
10635	20:28931	OSTI; NTIS; INIS; GPO Dep.	E 1.99:	DE96000199	MF-2000
10642	20:28932	OSTI; NTIS; INIS; GPO Dep.	E 1.99:	DE96001134	MF-2030
10643	20:28933	OSTI; NTIS; INIS; GPO Dep.	E 1.99:	DE96001137	MF-2030
10644	20:28934	OSTI; NTIS; INIS; GPO Dep.	E 1.99:	DE96001135	MF-2030
10666	20:28935	OSTI; NTIS; INIS; GPO Dep.	E 1.99:	DE95017598	MF-2020; MF-510
10683	20:28936	OSTI; NTIS; INIS; GPO Dep.	E 1.99:	DE95016038	MF-2030
10692	20:28937	OSTI; NTIS; INIS; GPO Dep.	E 1.99:	DE95017596	MF-2010; MF-510
10694	20:28938	OSTI; NTIS; INIS; GPO Dep.	E 1.99:	DE95017600	MF-2070
10696	20:28939	OSTI; NTIS; INIS; GPO Dep.	E 1.99:	DE96001154	MF-721
10697	20:28940	OSTI; NTIS; INIS; GPO Dep.	E 1.99:	DE96000750	MF-2030
10698	20:29105	OSTI; NTIS; INIS; GPO Dep.	E 1.99:	DE96001345	MF-2070
10700	20:29855	OSTI; NTIS; GPO Dep.	E 1.99:	DE96001344	MF-401
10705-Vol.1	20:29134	OSTI; NTIS; INIS; GPO Dep.	E 1.99:	DE95017593	MF-940
10711	20:30832	OSTI; NTIS; INIS; GPO Dep.	E 1.99:	DE95017602	MF-602
10712	20:28941	OSTI; NTIS; INIS; GPO Dep.	E 1.99:	DE95017592	MF-2030

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10715	20:29106	OSTI; NTIS; INIS; GPO Dep.	E 1.99:	DE96000198	MF-607
10725	20:28942	OSTI; NTIS; INIS; GPO Dep.	E 1.99:	DE96001200	MF-2030
10728	20:30745	OSTI; NTIS; INIS; GPO Dep.	E 1.99:	DE95017597	MF-2000; MF-603
10740	20:28943	OSTI; NTIS; INIS; GPO Dep.	E 1.99:	DE95017707	MF-2030
10741	20:29777	OSTI; NTIS; INIS; GPO Dep.	E 1.99:	DE96000730	
10743	20:28944	OSTI; NTIS; INIS; GPO Dep.	E 1.99:	DE96000203	MF-2020
10744	20:28945	OSTI; NTIS; INIS; GPO Dep.	E 1.99:	DE96000200	MF-721
10745	20:28946	OSTI; NTIS; INIS; GPO Dep.	E 1.99:	DE96000263	MF-410
10746	20:28947	OSTI; NTIS; INIS; GPO Dep.	E 1.99:	DE96000197	MF-2000
10754	20:28948	OSTI; NTIS; INIS; GPO Dep.	E 1.99:	DE96000748	MF-2030
10755	20:28949	OSTI; NTIS; INIS; GPO Dep.	E 1.99:	DE96000727	MF-2030
10757	20:30309	OSTI; NTIS; INIS; GPO Dep.	E 1.99:	DE96001341	MF-2060
10761	20:28950	OSTI; NTIS; INIS; GPO Dep.	E 1.99:	DE96000745	MF-2030
10762	20:28951	OSTI; NTIS; GPO Dep.	E 1.99:	DE96000732	MF-2030
10763	20:28952	OSTI; NTIS; GPO Dep.	E 1.99:	DE96000728	MF-2030
10765	20:28953	OSTI; NTIS; INIS; GPO Dep.	E 1.99:	DE96000729	MF-2030
10766	20:28954	OSTI; NTIS; INIS; GPO Dep.	E 1.99:	DE96000714	MF-2030
10771	20:29917	OSTI; NTIS; GPO Dep.	E 1.99:	DE96000202	MF-1600
10772	20:30221	OSTI; NTIS; INIS; GPO; GPO Dep.	E 1.99:	DE96000819	MF-2030
10777	20:28955	OSTI; NTIS; INIS; GPO Dep.	E 1.99:	DE96000731	MF-2030
10781	20:28956	OSTI; NTIS; INIS; GPO Dep.	E 1.99:	DE96000747	MF-2030
10785	20:28957	OSTI; NTIS; INIS; GPO Dep.	E 1.99:	DE96000713	MF-2030
10786	20:30746	OSTI; NTIS; INIS; GPO Dep.	E 1.99:	DE96000746	MF-2010
10787	20:29135	OSTI; NTIS; INIS; GPO Dep.	E 1.99:	DE96000749	MF-2000
10788	20:28958	OSTI; NTIS; INIS; GPO Dep.	E 1.99:	DE96000814	MF-2000
10789	20:30669	OSTI; NTIS; GPO Dep.	E 1.99:	DE96000744	MF-902
10791	20:29449	OSTI; NTIS; INIS; GPO Dep.	E 1.99:	DE96000693	
10792	20:28959	OSTI; NTIS; INIS; GPO Dep.	E 1.99:	DE96000818	MF-721
10815	20:28960	OSTI; NTIS; INIS; GPO Dep.	E 1.99:	DE96000813	MF-2030
10817	20:30747	OSTI; NTIS; INIS; GPO Dep.	E 1.99:	DE96001153	MF-2070
10834	20:30748	OSTI; NTIS; GPO Dep.	E 1.99:	DE96001419	MF-600
10839	20:29107	OSTI; NTIS; GPO Dep.	E 1.99:	DE96001147	MF-602
6415-Rev.7	20:30635	OSTI; NTIS; GPO Dep.	E 1.99:	DE95017595	MF-2000
8077	20:30840	OSTI; NTIS; GPO Dep.	E 1.99:	DE95017589	MF-602
8475	20:29518	OSTI; NTIS; INIS; GPO Dep.	E 1.99:	DE96001152	MF-523
PNL-D–					
394	20:29136	OSTI; NTIS; GPO Dep.	E 1.99:	DE95012667	MF-500
PNL-SA–					
23973	20:29918	OSTI; NTIS; GPO Dep.	E 1.99:	DE95014615	MF-400
24317	20:30370	OSTI; NTIS; GPO Dep.	E 1.99:	DE95014177	MF-413
25207	20:28961	OSTI; NTIS; INIS; GPO Dep.	E 1.99:	DE95014175	MF-2050
25595	20:28962	OSTI; NTIS; INIS; GPO Dep.	E 1.99:	DE95014182	MF-2010
25608	20:31044	OSTI; NTIS; INIS; GPO Dep.	E 1.99:	DE95016813	MF-407
25692	20:29788	OSTI; NTIS; GPO Dep.	E 1.99:	DE95016799	MF-906

Report Number	Abstract Number	Source of Availability	GPO Dep.	Order Number	Distribution Category
25847	20:30904	OSTI; NTIS; GPO Dep.	E 1.99:	DE95016806	MF-406
26246	20:29108	OSTI; NTIS; INIS; GPO Dep.	E 1.99:	DE95015826	MF-2020
26326	20:29881	OSTI; NTIS; GPO Dep.	E 1.99:	DE95016810	MF-1320
26339	20:31408	OSTI; NTIS; GPO Dep.	E 1.99:	DE95016816	
26402	20:28963	OSTI; NTIS; INIS; GPO Dep.	E 1.99:	DE95016818	MF-2080
26423	20:29109	OSTI; NTIS; INIS; GPO Dep.	E 1.99:	DE95016819	MF-2000
POEF-SH–					
34	20:30310	OSTI; NTIS; INIS; GPO Dep.	E 1.99:	DE95017168	MF-500
PPPL-CFP–					
3349	20:30311	OSTI; NTIS; INIS; GPO Dep.	E 1.99:	DE95014765	MF-420
3350	20:31191	OSTI; NTIS; INIS; GPO Dep.	E 1.99:	DE95014766	MF-420
PSI–					
1178/05/95	20:28672	*See* DOE/PC/92190–T8			
95-10	20:30222	OSTI; NTIS; INIS		DE96602466	
95-11	20:30223	OSTI; NTIS; INIS		DE96602467	
95-12	20:30224	OSTI; NTIS; INIS		DE96602468	
QMW-PH–					
95-17	20:30933	*See* IC–95/151			
95-24	20:30934	*See* IC–95/152			
RAE–					
9304/1-1	20:28814	*See* DOE/LLW–189			
RCHEP–					
33.	20:30959	*See* UM-P–94/118			
94/31	20:31034	*See* UM-P–94/113			
94/34.	20:30960	*See* UM-P–94/120			
94/37.	20:31035	*See* UM-P–94/133			
95/05.	20:30961	*See* UM-P–95/09			
95/08.	20:30962	*See* UM-P–95/12			
RECHP–					
95/09.	20:31036	*See* UM-P–95/23			
RINPO–					
0012.	20:29465	*See* CNIC–00959			
S-HRG–					
95016366	20:28971	OSTI; NTIS; INIS; GPO		TI95016366	
SAND–					
92-0252	20:29137	OSTI; NTIS; INIS; GPO Dep.	E 1.99:	DE96001349	MF-702
93-0528	20:29775	*See* NUREG/CR–6017			
93-1726/2	20:29138	OSTI; NTIS; INIS; GPO Dep.	E 1.99:	DE96000204	MF-515
93-7111	20:28964	OSTI; NTIS; INIS; GPO Dep.	E 1.99:	DE95017546	MF-721
94-0244	20:28965	OSTI; NTIS; INIS; GPO Dep.	E 1.99:	DE96000699	MF-814
94-0437	20:28966	OSTI; NTIS; INIS; GPO Dep.	E 1.99:	DE96000207	MF-814
94-0890	20:29032	OSTI; NTIS; INIS; GPO Dep.	E 1.99:	DE95016749	MF-2010
94-1376	20:29033	OSTI; NTIS; INIS; GPO Dep.	E 1.99:	DE95016954	MF-2010
94-1451	20:30371	OSTI; NTIS; GPO Dep.	E 1.99:	DE95017638	MF-704
94-1949	20:30244	OSTI; NTIS; GPO Dep.	E 1.99:	DE95016459	MF-2000
94-2019	20:29110	OSTI; NTIS; GPO Dep.	E 1.99:	DE95017632	MF-707
94-2217	20:28967	OSTI; NTIS; INIS; GPO Dep.	E 1.99:	DE96000692	MF-721
94-2268C	20:30312	OSTI; NTIS; INIS; GPO Dep.	E 1.99:	DE95006817	MF-2000
94-2384	20:30851	OSTI; NTIS; INIS; GPO Dep.	E 1.99:	DE96000205	MF-814
94-3060C	20:30590	OSTI; NTIS; GPO Dep.	E 1.99:	DE96000705	MF-741
94-3136C	20:31235	OSTI; NTIS; GPO Dep.	E 1.99:	DE95017882	MF-706
94-3143	20:29966	OSTI; NTIS; GPO Dep.	E 1.99:	DE96001364	MF-1290
94-3223	20:29856	OSTI; NTIS; GPO Dep.	E 1.99:	DE95017836	MF-700
94-3230C	20:30350	OSTI; NTIS; GPO Dep.	E 1.99:	DE95017896	MF-706
95-0009C	20:30343	OSTI; NTIS; GPO Dep.	E 1.99:	DE95017886	MF-706
95-0264C	20:30558	OSTI; NTIS; GPO Dep.	E 1.99:	DE95016085	MF-705
95-0338	20:29857	OSTI; NTIS; GPO Dep.	E 1.99:	DE95012524	MF-1300
95-0471C	20:31368	OSTI; NTIS; GPO Dep.	E 1.99:	DE95015081	MF-706
95-0514C	20:30372	OSTI; NTIS; GPO Dep.	E 1.99:	DE95017838	MF-706
95-0518C	20:30351	OSTI; NTIS; GPO Dep.	E 1.99:	DE95015433	MF-743
95-0536	20:30277	OSTI; NTIS; GPO Dep.	E 1.99:	DE95017636	MF-706

Report Number	Abstract Number	Source of Availability	GPO Dep.	Order Number	Distribution Category
95-0591	20:28968	OSTI; NTIS; INIS; GPO Dep.	E 1.99:	DE96001139	MF-814
95-0666C-Rev.	20:31409	OSTI; NTIS; GPO Dep.	E 1.99:	DE95016091	MF-706
95-0782C	20:30139	OSTI; NTIS; GPO Dep.	E 1.99:	DE96000778	MF-904
95-0804C	20:31236	OSTI; NTIS; INIS; GPO Dep.	E 1.99:	DE96000776	MF-423
95-0838C	20:30140	OSTI; NTIS; GPO Dep.	E 1.99:	DE96000787	MF-704
95-0949C	20:30141	OSTI; NTIS; GPO Dep.	E 1.99:	DE95017888	MF-704
95-0958C	20:29946	OSTI; NTIS; GPO Dep.	E 1.99:	DE95014839	MF-700
95-0961	20:30225	OSTI; NTIS; GPO Dep.	E 1.99:	DE96000057	MF-701
95-1059C	20:30373	OSTI; NTIS; GPO Dep.	E 1.99:	DE96000756	MF-704
95-1060	20:30374	OSTI; NTIS; GPO Dep.	E 1.99:	DE96000056	MF-700
95-1080	20:29947	OSTI; NTIS; GPO Dep.	E 1.99:	DE95017798	MF-700
95-1094C	20:31369	OSTI; NTIS; GPO Dep.	E 1.99:	DE95016743	MF-705
95-1143C	20:29948	OSTI; NTIS; GPO Dep.	E 1.99:	DE95014843	MF-706
95-1149C	20:30313	OSTI; NTIS; GPO Dep.	E 1.99:	DE95015084	MF-706
95-1234C	20:31370	OSTI; NTIS; GPO Dep.	E 1.99:	DE95013833	MF-705
95-1247	20:30749	OSTI; NTIS; GPO Dep.	E 1.99:	DE95017639	MF-403
95-1329C	20:30570	OSTI; NTIS; GPO Dep.	E 1.99:	DE95014847	
95-1385C	20:31153	OSTI; NTIS; GPO Dep.	E 1.99:	DE96000785	
95-1433C	20:30571	OSTI; NTIS; GPO Dep.	E 1.99:	DE95014846	
95-1450C	20:29139	OSTI; NTIS; INIS; GPO Dep.	E 1.99:	DE95014845	MF-940
95-1451C	20:29140	OSTI; NTIS; INIS; GPO Dep.	E 1.99:	DE95015079	MF-940
95-1461	20:28969	OSTI; NTIS; INIS; GPO Dep.	E 1.99:	DE95016952	MF-721
95-1508C	20:30375	OSTI; NTIS; GPO Dep.	E 1.99:	DE95015091	MF-706
95-1522C	20:30376	OSTI; NTIS; GPO Dep.	E 1.99:	DE95015060	MF-706
95-1547C	20:29949	OSTI; NTIS; GPO Dep.	E 1.99:	DE95015245	MF-704
95-1551/1	20:30572	OSTI; NTIS; GPO Dep.	E 1.99:	DE95017635	MF-706
95-1551/2	20:30314	OSTI; NTIS; GPO Dep.	E 1.99:	DE95017581	MF-706
95-1635C	20:30315	OSTI; NTIS; GPO Dep.	E 1.99:	DE95015851	MF-706
95-1648	20:29845	OSTI; NTIS; GPO Dep.	E 1.99:	DE95016765	MF-630
95-1650C	20:29982	OSTI; NTIS; GPO Dep.	E 1.99:	DE95015539	MF-700
95-1671C	20:30548	OSTI; NTIS; GPO Dep.	E 1.99:	DE95016090	MF-706
95-1693	20:31237	OSTI; NTIS; INIS; GPO Dep.	E 1.99:	DE96000055	MF-420
95-1751C	20:30142	OSTI; NTIS; GPO Dep.	E 1.99:	DE95016405	MF-704
95-1758	20:29111	OSTI; NTIS; INIS; GPO Dep.	E 1.99:	DE95017835	MF-2000
95-1775	20:30549	OSTI; NTIS; GPO Dep.	E 1.99:	DE95017633	MF-706
95-1795	20:29112	OSTI; NTIS; GPO Dep.	E 1.99:	DE95017631	MF-607
95-1831C	20:30618	OSTI; NTIS; GPO Dep.	E 1.99:	DE95016760	MF-900
95-183OC	20:29987	OSTI; NTIS; GPO Dep.	E 1.99:	DE95016759	MF-903
95-1841	20:30573	OSTI; NTIS; GPO Dep.	E 1.99:	DE96000206	MF-706
95-1884C	20:30550	OSTI; NTIS; GPO Dep.	E 1.99:	DE95016755	MF-700
95-1885C	20:30377	OSTI; NTIS; GPO Dep.	E 1.99:	DE95016761	MF-704
95-1892C	20:30378	OSTI; NTIS; GPO Dep.	E 1.99:	DE95016733	MF-700
95-1901C	20:31371	OSTI; NTIS; GPO Dep.	E 1.99:	DE95016742	MF-705
95-1906	20:29141	OSTI; NTIS; INIS; GPO Dep.	E 1.99:	DE96001327	MF-515
95-1935C	20:30537	OSTI; NTIS; GPO Dep.	E 1.99:	DE95017550	MF-706
95-1937C	20:30379	OSTI; NTIS; GPO Dep.	E 1.99:	DE95017566	MF-706
95-1950	20:30380	OSTI; NTIS; GPO Dep.	E 1.99:	DE96000700	MF-910
95-1953	20:29113	OSTI; NTIS; INIS; GPO Dep.	E 1.99:	DE96001365	MF-630
95-1958C	20:30183	OSTI; NTIS; GPO Dep.	E 1.99:	DE95017573	MF-704
95-1969C	20:30143	OSTI; NTIS; INIS; GPO Dep.	E 1.99:	DE96000763	MF-404
95-1976C	20:31103	OSTI; NTIS; GPO Dep.	E 1.99:	DE95017893	MF-404
95-1989C	20:28635	OSTI; NTIS; GPO Dep.	E 1.99:	DE95017892	MF-108
95-1990C	20:28774	OSTI; NTIS; INIS; GPO Dep.	E 1.99:	DE95017884	MF-940; MF-812
95-1991C	20:29477	OSTI; NTIS; INIS; GPO Dep.	E 1.99:	DE95017891	MF-812
95-1992C	20:30344	OSTI; NTIS; GPO Dep.	E 1.99:	DE95017879	MF-706
95-2012C	20:29142	OSTI; NTIS; INIS; GPO Dep.	E 1.99:	DE95017889	MF-706
95-2053	20:30615	OSTI; NTIS; GPO Dep.	E 1.99:	DE96000703	MF-706
95-2056C	20:30381	OSTI; NTIS; GPO Dep.	E 1.99:	DE95017894	MF-706
95-2058C	20:30382	OSTI; NTIS; GPO Dep.	E 1.99:	DE95017895	MF-705
95-2062C	20:30670	OSTI; NTIS; GPO Dep.	E 1.99:	DE96000684	MF-402; MF-406
95-2078C	20:29401	OSTI; NTIS; GPO Dep.	E 1.99:	DE95017887	MF-1290
95-2101C	20:30144	OSTI; NTIS; GPO Dep.	E 1.99:	DE96000782	MF-704
95-2102C	20:30145	OSTI; NTIS; GPO Dep.	E 1.99:	DE96000783	MF-704
95-2108C	20:30146	OSTI; NTIS; GPO Dep.	E 1.99:	DE96000707	MF-704
95-2125C	20:29143	OSTI; NTIS; INIS; GPO Dep.	E 1.99:	DE96000784	MF-900
95-2128	20:30574	OSTI; NTIS; GPO Dep.	E 1.99:	DE96001328	MF-607
95-2134C	20:31372	OSTI; NTIS; GPO Dep.	E 1.99:	DE96000723	MF-705

Report Number	Abstract Number	Source of Availability	GPO Dep.	Order Number	Distribution Category
SAND–					
95-2135C	20:29144	OSTI; NTIS; INIS; GPO Dep.	E 1.99:	DE96000720	MF-940
95-2136C	20:29145	OSTI; NTIS; INIS; GPO Dep.	E 1.99:	DE96000721	MF-700
95-2145C	20:29146	OSTI; NTIS; INIS; GPO Dep.	E 1.99:	DE96000722	MF-940
95-2147C-Draft	20:31410	OSTI; NTIS; GPO; GPO Dep.	E 1.99:	DE96000777	MF-905
95-2180C	20:30147	OSTI; NTIS; GPO Dep.	E 1.99:	DE96000708	MF-704
95-2181C	20:28636	OSTI; NTIS; GPO Dep.	E 1.99:	DE96000786	MF-108
95-2192C	20:30148	OSTI; NTIS; GPO Dep.	E 1.99:	DE96000698	MF-704
95-2195C	20:31373	OSTI; NTIS; GPO Dep.	E 1.99:	DE96000719	MF-905
95-2244C	20:28970	OSTI; NTIS; INIS; GPO Dep.	E 1.99:	DE96000704	MF-2000
95-2245C	20:31374	OSTI; NTIS; GPO Dep.	E 1.99:	DE96000685	ND-705
95-2254C	20:30149	OSTI; NTIS; GPO Dep.	E 1.99:	DE96000788	MF-704
95-2256C	20:31309	OSTI; NTIS; GPO Dep.	E 1.99:	DE96000755	MF-900
95-2258C	20:29114	OSTI; NTIS; INIS; GPO Dep.	E 1.99:	DE96000780	MF-2020
95-2261C	20:30383	OSTI; NTIS; GPO Dep.	E 1.99:	DE96000709	MF-706
95-2267C	20:29115	OSTI; NTIS; INIS; GPO Dep.	E 1.99:	DE96000706	MF-703
95-2271C	20:30352	OSTI; NTIS; GPO Dep.	E 1.99:	DE96000779	MF-906
95-8258	20:30794	OSTI; NTIS; GPO Dep.	E 1.99:	DE96000869	MF-405
95-8488	20:30863	OSTI; NTIS; GPO Dep.	E 1.99:	DE95017522	MF-405
95-8633C	20:30226	OSTI; NTIS; GPO Dep.	E 1.99:	DE95016389	MF-411
95-8634C	20:29313	OSTI; NTIS; GPO Dep.	E 1.99:	DE95015993	MF-1409
95-8688C	20:29950	OSTI; NTIS; GPO Dep.	E 1.99:	DE95016388	MF-406
SEA–					
90-500-02-A:1	20:29584	*See* LA-SUB–95-175-A:1			
90-500-02-A:3	20:29585	*See* LA-SUB–95-175-A:3			
90-500-02-A:5	20:29586	*See* LA-SUB–95-175-A:5			
SLAC–					
423	20:31130	OSTI; NTIS; INIS; GPO Dep.	E 1.99:	DE95016467	PC-410
438	20:31131	OSTI; NTIS; INIS; GPO Dep.	E 1.99:	DE95014374	MF-410
452	20:31012	OSTI; NTIS; INIS; GPO Dep.	E 1.99:	DE95014375	MF-414
454	20:31013	OSTI; NTIS; INIS; GPO Dep.	E 1.99:	DE95014376	MF-414
95-6811	20:30476	OSTI; NTIS; INIS; GPO Dep.	E 1.99:	DE95017720	MF-414
SLAC-PUB–					
95-6676	20:30477	OSTI; NTIS; INIS; GPO Dep.	E 1.99:	DE95017366	MF-414
95-6744	20:31375	OSTI; NTIS; GPO Dep.	E 1.99:	DE95016511	MF-405
95-6757	20:30413	OSTI; NTIS; INIS; GPO Dep.	E 1.99:	DE95017717	MF-414
95-6760	20:30864	OSTI; NTIS; INIS; GPO Dep.	E 1.99:	DE96001000	MF-414
95-6798	20:30478	OSTI; NTIS; INIS; GPO Dep.	E 1.99:	DE95017718	MF-414
95-6803	20:30479	OSTI; NTIS; INIS; GPO Dep.	E 1.99:	DE95017719	MF-414
95-6818	20:30498	OSTI; NTIS; INIS; GPO Dep.	E 1.99:	DE95017721	MF-414
95-6835	20:30384	OSTI; NTIS; INIS; GPO Dep.	E 1.99:	DE95017722	MF-414
95-6847	20:30435	OSTI; NTIS; INIS; GPO Dep.	E 1.99:	DE95017723	MF-414
95-6856	20:30436	OSTI; NTIS; INIS; GPO Dep.	E 1.99:	DE95017724	MF-414
95-6915	20:30905	OSTI; NTIS; GPO Dep.	E 1.99:	DE95017367	MF-414
95-6916	20:31014	OSTI; NTIS; INIS; GPO Dep.	E 1.99:	DE95016510	MF-414
95-6933	20:31015	OSTI; NTIS; INIS; GPO Dep.	E 1.99:	DE95017368	MF-414
95-6934	20:30957	OSTI; NTIS; INIS; GPO Dep.	E 1.99:	DE95017725	MF-414
95-6936	20:30437	OSTI; NTIS; INIS; GPO Dep.	E 1.99:	DE95017726	MF-414
95-6937	20:30991	OSTI; NTIS; INIS; GPO Dep.	E 1.99:	DE95017727	MF-414
95-6939	20:30808	OSTI; NTIS; INIS; GPO Dep.	E 1.99:	DE95017728	MF-406; MF-414
95-6954	20:30499	OSTI; NTIS; INIS; GPO Dep.	E 1.99:	DE95017369	MF-414
95-6960	20:30992	OSTI; NTIS; INIS; GPO Dep.	E 1.99:	DE95017729	MF-414
95-6968	20:30523	OSTI; NTIS; INIS; GPO Dep.	E 1.99:	DE96001022	MF-414
95-7004	20:31016	OSTI; NTIS; INIS; GPO Dep.	E 1.99:	DE96001023	MF-414
SLAC-R–					
95-472	20:30438	OSTI; NTIS; INIS; GPO Dep.	E 1.99:	DE96000816	PC-414
95-473	20:31017	OSTI; NTIS; INIS; GPO Dep.	E 1.99:	DE96000817	PC-414
SLAC/SSRL–					
0057	20:31130	*See* SLAC–423			
SLU-EKOMIL-R–					
73	20:29351	OSTI; NTIS; INIS		DE96703709	
80	20:29352	OSTI; NTIS; INIS		DE96703708	
SMHI-RH–					
10	20:30777	OSTI; NTIS		DE96703707	
SSC-SR–					
1018	20:30483	OSTI; NTIS; GPO Dep.	E 1.99:	DE95011081	MF-414
1023	20:30484	OSTI; NTIS; GPO Dep.	E 1.99:	DE95011085	MF-414
1026	20:30415	OSTI; NTIS; GPO Dep.	E 1.99:	DE95011088	MF-414

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1028	20:30485	OSTI; NTIS; GPO Dep.	E 1.99:	DE95011090	MF-414
1031	20:30416	OSTI; NTIS; GPO Dep.	E 1.99:	DE95011092	MF-414
1036	20:30486	OSTI; NTIS; GPO Dep.	E 1.99:	DE95011097	MF-414
1039	20:30524	OSTI; NTIS; GPO Dep.	E 1.99:	DE95011099	MF-414
SSCL–					
282	20:30439	OSTI; NTIS; INIS; GPO Dep.	E 1.99:	DE95011226	MF-414; MF-405
573	20:30480	OSTI; NTIS; INIS; GPO Dep.	E 1.99:	DE95011190	MF-414
SSCL-Preprint–					
223	20:30440	OSTI; NTIS; INIS; GPO Dep.	E 1.99:	DE95011195	MF-414
509-Rev.1	20:30481	OSTI; NTIS; INIS; GPO Dep.	E 1.99:	DE95011221	MF-414
510	20:30441	OSTI; NTIS; INIS; GPO Dep.	E 1.99:	DE95011220	MF-414
SSCL-SR–					
1029	20:30482	OSTI; NTIS; INIS; GPO Dep.	E 1.99:	DE95011091	MF-414
1222	20:30414	OSTI; NTIS; INIS; GPO Dep.	E 1.99:	DE95011789	MF-414
SSN–					
95-26	20:29984	*See* BNL–52477			
95-34	20:30198	*See* BNL–62155			
UCB-PTH–					
95/19	20:30990	*See* LBL–37425			
UCRL–					
78378	20:31100	OSTI; NTIS; GPO Dep.	E 1.99:	DE95017708	MF-705
UCRL-CR–					
110675	20:28743	OSTI; NTIS; GPO Dep.	E 1.99:	DE96000356	MF-930
115353-95	20:29376	OSTI; NTIS; GPO Dep.	E 1.99:	DE96000357	MF-904
118475	20:30809	OSTI; NTIS; INIS; GPO Dep.	E 1.99:	DE96000844	
119157	20:30551	OSTI; NTIS; GPO Dep.	E 1.99:	DE95017256	MF-905
120303	20:30385	OSTI; NTIS; GPO Dep.	E 1.99:	DE96000355	MF-900
120464	20:30075	OSTI; NTIS; INIS; GPO Dep.	E 1.99:	DE95015979	MF-804
121206	20:30619	OSTI; NTIS; GPO Dep.	E 1.99:	DE95015410	MF-703
121458	20:30386	OSTI; NTIS; GPO Dep.	E 1.99:	DE95017254	MF-712
121663/S/C-B249873	20:30076	OSTI; NTIS; GPO Dep.	E 1.99:	DE96000852	MF-705
121818	20:30575	OSTI; NTIS; GPO Dep.	E 1.99:	DE96000352	MF-741
121838	20:30591	OSTI; NTIS; GPO Dep.	E 1.99:	DE96000374	MF-700
121900	20:30620	OSTI; NTIS; GPO Dep.	E 1.99:	DE95017844	MF-702
122068	20:28972	OSTI; NTIS; INIS; GPO Dep.	E 1.99:	DE96000372	MF-702
UCRL-ID–					
110062-94-6	20:30833	OSTI; NTIS; GPO Dep.	E 1.99:	DE95017265	MF-902
113867-95	20:29116	OSTI; NTIS; GPO Dep.	E 1.99:	DE95017842	MF-902
114369	20:30750	OSTI; NTIS; GPO Dep.	E 1.99:	DE96000101	MF-702
116187-95-1	20:28973	OSTI; NTIS; GPO Dep.	E 1.99:	DE95017299	MF-902
116187-95-6	20:28974	OSTI; NTIS; GPO Dep.	E 1.99:	DE95017302	MF-702
117333	20:28782	OSTI; NTIS; GPO Dep.	E 1.99:	DE95017263	MF-721
118509	20:31239	OSTI; NTIS; INIS; GPO Dep.	E 1.99:	DE95017715	MF-712
118676	20:30592	OSTI; NTIS; GPO Dep.	E 1.99:	DE95017036	MF-930
118678	20:30778	OSTI; NTIS; GPO Dep.	E 1.99:	DE95017038	MF-903
118861	20:28762	OSTI; NTIS; GPO Dep.	E 1.99:	DE96000840	MF-700
118940	20:30184	OSTI; NTIS; INIS; GPO Dep.	E 1.99:	DE96000841	MF-700
118941	20:30276	OSTI; NTIS; GPO Dep.	E 1.99:	DE96000820	MF-700
119105	20:28975	OSTI; NTIS; GPO Dep.	E 1.99:	DE96001170	MF-902
119189	20:30616	OSTI; NTIS (US Sales Only); GPO Dep.	E 1.99:	DE95017716	MF-700
119210	20:30753	OSTI; NTIS; INIS; GPO Dep.	E 1.99:	DE95017056	MF-902
119303	20:30834	OSTI; NTIS; GPO Dep.	E 1.99:	DE96000358	MF-907
119329	20:31310	OSTI; NTIS; GPO Dep.	E 1.99:	DE96001073	MF-900
119453	20:31379	OSTI; NTIS; GPO Dep.	E 1.99:	DE95017859	MF-700
119535-5	20:30387	OSTI; NTIS; GPO Dep.	E 1.99:	DE95017883	MF-706
119564-Vol.1	20:28976	OSTI; NTIS; INIS; GPO Dep.	E 1.99:	DE96000369	MF-814; MF-804
119564-Vol.2	20:28977	OSTI; NTIS; INIS; GPO Dep.	E 1.99:	DE96000370	MF-814; MF-804
119564-vol.3	20:28978	OSTI; NTIS; INIS; GPO Dep.	E 1.99:	DE96000371	MF-814; MF-804
119645	20:30185	OSTI; NTIS; GPO Dep.	E 1.99:	DE95017863	MF-701
119656	20:30754	OSTI; INIS; NTIS; GPO Dep.	E 1.99:	DE95017057	MF-703
119660	20:30796	OSTI; NTIS; GPO Dep.	E 1.99:	DE95017042	MF-908
119685	20:29968	OSTI; NTIS; GPO Dep.	E 1.99:	DE95017043	MF-950
119708	20:30841	OSTI; NTIS; GPO Dep.	E 1.99:	DE96000368	MF-408
119759	20:30755	OSTI; NTIS; INIS; GPO Dep.	E 1.99:	DE96000333	MF-902
119841	20:29923	OSTI; NTIS; GPO Dep.	E 1.99:	DE96000842	MF-900
119842	20:28979	OSTI; NTIS; INIS; GPO Dep.	E 1.99:	DE95017857	MF-702
120051	20:30807	*See* NUREG/CR–6323			

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Report Number	*Abstract Number*	*Source of Availability*	*GPO Dep.*	*Order Number*	*Distribution Category*
120056	20:29186	*See* NUREG/CR–6324			
120238	20:31240	OSTI; NTIS; INIS; GPO Dep.	E 1.99:	DE95017074	MF-410
120378	20:31104	OSTI; NTIS; INIS; GPO Dep.	E 1.99:	DE95017029	MF-901
120392	20:30077	OSTI; NTIS; GPO Dep.	E 1.99:	DE95016054	MF-904
120467	20:30906	OSTI; NTIS; GPO Dep.	E 1.99:	DE95012482	MF-405; MF-402
120523	20:28980	OSTI; NTIS; INIS; GPO Dep.	E 1.99:	DE96000353	MF-700
120596	20:30417	OSTI; NTIS; INIS; GPO Dep.	E 1.99:	DE96001007	MF-701
120758	20:31241	OSTI; NTIS; GPO Dep.	E 1.99:	DE95017854	MF-712
120801	20:30552	OSTI; NTIS; GPO Dep.	E 1.99:	DE95017714	MF-700
120854	20:30626	OSTI; NTIS (US Sales Only); GPO Dep.	E 1.99:	DE96001052	MF-700
120900	20:31380	OSTI; NTIS; INIS; GPO Dep.	E 1.99:	DE96000330	MF-712
121109	20:29147	OSTI; NTIS; INIS; GPO Dep.	E 1.99:	DE96000137	MF-900
121163	20:30316	OSTI; NTIS; INIS; GPO Dep.	E 1.99:	DE96001009	MF-940
121170	20:31242	OSTI; NTIS; INIS; GPO Dep.	E 1.99:	DE96001053	MF-900
121173	20:31152	OSTI; NTIS; GPO Dep.	E 1.99:	DE96000376	MF-400
121182	20:29952	OSTI; NTIS; GPO Dep.	E 1.99:	DE95017713	MF-701
121332	20:30186	OSTI; NTIS; GPO Dep.	E 1.99:	DE95017899	MF-701
121333	20:31243	OSTI; NTIS; GPO Dep.	E 1.99:	DE95017898	MF-712
121379	20:31192	OSTI; NTIS; INIS; GPO Dep.	E 1.99:	DE96001008	MF-426
121413	20:30672	OSTI; NTIS; GPO Dep.	E 1.99:	DE96001010	MF-402
121414	20:30673	OSTI; NTIS; GPO Dep.	E 1.99:	DE96001011	MF-402
121415	20:30674	OSTI; NTIS; GPO Dep.	E 1.99:	DE96001012	MF-402
121434	20:28783	OSTI; NTIS; INIS; GPO Dep.	E 1.99:	DE96000843	MF-722
121512	20:30675	OSTI; NTIS; INIS; GPO Dep.	E 1.99:	DE95017070	MF-402; MF-902
121523	20:31381	OSTI; NTIS; GPO Dep.	E 1.99:	DE96000329	MF-703; MF-705
121566-Pt.1	20:30559	OSTI; NTIS; GPO Dep.	E 1.99:	DE96001143	MF-900
121566-Pt.2	20:30560	OSTI; NTIS; GPO Dep.	E 1.99:	DE96001144	MF-900
121651	20:30187	OSTI; NTIS; GPO Dep.	E 1.99:	DE95017897	MF-701
121669	20:30577	OSTI; NTIS; GPO Dep.	E 1.99:	DE96000870	MF-706
121679	20:30317	OSTI; NTIS; GPO Dep.	E 1.99:	DE96001024	MF-706
121682	20:30779	OSTI; NTIS; GPO Dep.	E 1.99:	DE96000881	MF-702
121728	20:31193	OSTI; NTIS; INIS; GPO Dep.	E 1.99:	DE96001025	MF-900
121755	20:30593	OSTI; NTIS; GPO Dep.	E 1.99:	DE95017301	MF-706
121808	20:30811	OSTI; NTIS; GPO Dep.	E 1.99:	DE96000839	MF-712
121824	20:29988	OSTI; NTIS; GPO Dep.	E 1.99:	DE95017465	MF-742
121826	20:31194	OSTI; NTIS; GPO Dep.	E 1.99:	DE96000373	MF-742
121832	20:30553	OSTI; NTIS; GPO Dep.	E 1.99:	DE96000752	MF-906
121923	20:30676	OSTI; NTIS; GPO Dep.	E 1.99:	DE96001021	MF-502
121951	20:30780	OSTI; NTIS; GPO Dep.	E 1.99:	DE96001026	MF-502
122013	20:30781	OSTI; NTIS; GPO Dep.	E 1.99:	DE96000375	MF-712
122058	20:28981	OSTI; NTIS; GPO Dep.	E 1.99:	DE96000195	MF-902
122067	20:30621	OSTI; NTIS; GPO Dep.	E 1.99:	DE96000423	MF-702
122069	20:30617	OSTI; NTIS; INIS; GPO Dep.	E 1.99:	DE96000332	MF-702
122106	20:30907	OSTI; NTIS; GPO Dep.	E 1.99:	DE96000829	MF-910
20736	20:30576	OSTI; NTIS; GPO Dep.	E 1.99:	DE95011600	MF-705
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105760	20:30078	OSTI; NTIS; GPO Dep.	E 1.99:	DE96000085	MF-706
116594	20:30756	OSTI; NTIS; GPO Dep.	E 1.99:	DE95017856	MF-902
116595	20:30677	OSTI; NTIS; INIS; GPO Dep.	E 1.99:	DE96000359	MF-902
116997	20:30079	OSTI; NTIS; GPO Dep.	E 1.99:	DE96000090	MF-712
117078-Rev.1	20:30318	OSTI; NTIS; GPO Dep.	E 1.99:	DE95011751	MF-712
117365	20:31245	OSTI; NTIS; INIS; GPO Dep.	E 1.99:	DE96000336	MF-712
11737-R1	20:30594	OSTI; NTIS; GPO Dep.	E 1.99:	DE96000349	MF-704
117698-Rev.1	20:31246	OSTI; NTIS; INIS; GPO Dep.	E 1.99:	DE95015035	MF-712
117814	20:31247	OSTI; NTIS; GPO Dep.	E 1.99:	DE95017846	MF-712
118024	20:30757	OSTI; NTIS; INIS; GPO Dep.	E 1.99:	DE96000360	MF-2000
118103	20:30388	OSTI; NTIS; INIS; GPO Dep.	E 1.99:	DE96000337	MF-712
118194	20:30389	OSTI; NTIS; INIS; GPO Dep.	E 1.99:	DE96000096	MF-712
118362	20:30873	OSTI; NTIS; GPO Dep.	E 1.99:	DE95011727	MF-712
118659	20:31248	OSTI; NTIS; INIS; GPO Dep.	E 1.99:	DE95016051	MF-900
118834	20:31195	OSTI; NTIS; INIS; GPO Dep.	E 1.99:	DE95015983	MF-712
118903	20:30535	OSTI; NTIS; GPO Dep.	E 1.99:	DE96000364	MF-707
118923	20:30852	OSTI; NTIS; GPO Dep.	E 1.99:	DE95015992	MF-703
118964	20:30080	OSTI; NTIS; GPO Dep.	E 1.99:	DE95015884	MF-904
119019	20:31249	OSTI; NTIS; INIS; GPO Dep.	E 1.99:	DE96000725	MF-712
119068	20:31196	OSTI; NTIS; GPO Dep.	E 1.99:	DE95017273	MF-905
119082	20:30500	OSTI; NTIS; GPO Dep.	E 1.99:	DE96000084	MF-706

Report Number	Abstract Number	Source of Availability	GPO Dep.	Order Number	Distribution Category
119208	20:30501	OSTI; NTIS; INIS; GPO Dep.	E 1.99:	DE95017035	MF-414
119218	20:30853	OSTI; NTIS; GPO Dep.	E 1.99:	DE95015894	MF-703
119253	20:30595	OSTI; NTIS; GPO Dep.	E 1.99:	DE95017292	MF-904
119269	20:29919	OSTI; NTIS; GPO Dep.	E 1.99:	DE95017291	MF-901
119326	20:31197	OSTI; NTIS; INIS; GPO Dep.	E 1.99:	DE95017877	MF-712
119358	20:30487	OSTI; NTIS; INIS; GPO Dep.	E 1.99:	DE96000390	MF-712
119359	20:31250	OSTI; NTIS; INIS; GPO Dep.	E 1.99:	DE95015420	MF-712
119360	20:30488	OSTI; NTIS; INIS; GPO Dep.	E 1.99:	DE96000389	MF-712
119362	20:30390	OSTI; NTIS; INIS; GPO Dep.	E 1.99:	DE95015980	MF-712
119387	20:30624	OSTI; NTIS; GPO Dep.	E 1.99:	DE96000380	MF-712
119406	20:30489	OSTI; NTIS; GPO Dep.	E 1.99:	DE96000082	MF-406
119435-Rev.1	20:29034	OSTI; NTIS; INIS; GPO Dep.	E 1.99:	DE96000081	MF-700
119497	20:30578	OSTI; NTIS; GPO Dep.	E 1.99:	DE96000077	MF-712
119498	20:30579	OSTI; NTIS; GPO Dep.	E 1.99:	DE96000097	MF-700
119538	20:31251	OSTI; NTIS; INIS; GPO Dep.	E 1.99:	DE96000379	MF-712
119539	20:31252	OSTI; NTIS; INIS; GPO Dep.	E 1.99:	DE96001319	MF-712
119579	20:31253	OSTI; NTIS; INIS; GPO Dep.	E 1.99:	DE96001318	MF-712
119582	20:30490	OSTI; NTIS; GPO Dep.	E 1.99:	DE95017853	MF-712
119583	20:31254	OSTI; NTIS; INIS; GPO Dep.	E 1.99:	DE95017878	MF-712
119752	20:31382	OSTI; NTIS; INIS; GPO Dep.	E 1.99:	DE96000335	MF-405; MF-413
119758	20:31383	OSTI; NTIS; GPO Dep.	E 1.99:	DE96000334	MF-405; MF-402
119772-Rev.1	20:31384	OSTI; NTIS; GPO Dep.	E 1.99:	DE95017813	MF-705
119787	20:31385	OSTI; NTIS; GPO Dep.	E 1.99:	DE96000331	MF-905
119863	20:30758	OSTI; NTIS; GPO Dep.	E 1.99:	DE95015375	MF-706
119891	20:28982	OSTI; NTIS; INIS; GPO Dep.	E 1.99:	DE96000338	MF-700
119956	20:30081	OSTI; NTIS; GPO Dep.	E 1.99:	DE95017861	MF-704
119957	20:30908	OSTI; NTIS; GPO Dep.	E 1.99:	DE96000347	MF-700
120092	20:30909	OSTI; NTIS; GPO Dep.	E 1.99:	DE95011723	MF-410
120138	20:30596	OSTI; NTIS; GPO Dep.	E 1.99:	DE95017814	MF-904
120139	20:30597	OSTI; NTIS; GPO Dep.	E 1.99:	DE95017874	MF-904
120140	20:30598	OSTI; NTIS; GPO Dep.	E 1.99:	DE95017876	MF-904
120141	20:28983	OSTI; NTIS; GPO Dep.	E 1.99:	DE95017293	MF-901
120175	20:31255	OSTI; NTIS; GPO Dep.	E 1.99:	DE95017855	MF-712
120184	20:31256	OSTI; NTIS; INIS; GPO Dep.	E 1.99:	DE96000377	MF-712
120185	20:31257	OSTI; NTIS; GPO Dep.	E 1.99:	DE95016630	MF-712
120187-Rev.1	20:30391	OSTI; NTIS; INIS; GPO Dep.	E 1.99:	DE96000098	MF-712
120189	20:31258	OSTI; NTIS; GPO Dep.	E 1.99:	DE95016611	MF-700
120203	20:31259	OSTI; NTIS; GPO Dep.	E 1.99:	DE95016628	MF-712
120213	20:31260	OSTI; NTIS; INIS; GPO Dep.	E 1.99:	DE96000075	MF-712
120220	20:31261	OSTI; NTIS; INIS; GPO Dep.	E 1.99:	DE96000099	MF-712
120301	20:28706	OSTI; NTIS; GPO Dep.	E 1.99:	DE96000073	MF-900
120314	20:29814	OSTI; NTIS; GPO Dep.	E 1.99:	DE95017815	MF-904
120315	20:30188	OSTI; NTIS; GPO Dep.	E 1.99:	DE95017841	MF-904
120325	20:29974	OSTI; NTIS; GPO Dep.	E 1.99:	DE95017816	MF-900
120330	20:30353	OSTI; NTIS; GPO Dep.	E 1.99:	DE96000079	MF-706
120345	20:30082	OSTI; NTIS; GPO Dep.	E 1.99:	DE95015885	MF-904
120350	20:30319	OSTI; NTIS; INIS; GPO Dep.	E 1.99:	DE96001749	MF-940
120364	20:31262	OSTI; NTIS; GPO Dep.	E 1.99:	DE95014940	MF-906
120389	20:28984	OSTI; NTIS; INIS; GPO Dep.	E 1.99:	DE95015887	MF-902
120413	20:31198	OSTI; NTIS; GPO Dep.	E 1.99:	DE95017045	MF-700
120492	20:30345	OSTI; NTIS; GPO Dep.	E 1.99:	DE96000080	MF-905
120520	20:31263	OSTI; NTIS; GPO Dep.	E 1.99:	DE96000091	MF-712
120535	20:30320	OSTI; NTIS; GPO Dep.	E 1.99:	DE96000087	MF-702
120547	20:28985	OSTI; NTIS; GPO Dep.	E 1.99:	DE96000086	MF-706
120550	20:30554	OSTI; NTIS; GPO Dep.	E 1.99:	DE95017847	MF-706
120613	20:30759	OSTI; NTIS; INIS; GPO Dep.	E 1.99:	DE96000394	MF-702
120614	20:29117	OSTI; NTIS; INIS; GPO Dep.	E 1.99:	DE96000328	MF-702
120640	20:30392	OSTI; NTIS; GPO Dep.	E 1.99:	DE96000417	MF-700
12065	20:31244	OSTI; NTIS; INIS; GPO Dep.	E 1.99:	DE96001317	MF-405
120702	20:30083	OSTI; NTIS; GPO Dep.	E 1.99:	DE96000712	MF-712
120707	20:31264	OSTI; NTIS; INIS; GPO Dep.	E 1.99:	DE96000339	MF-712
120710	20:30580	OSTI; NTIS; GPO Dep.	E 1.99:	DE95017825	MF-706
120767	20:31265	OSTI; NTIS; INIS; GPO Dep.	E 1.99:	DE96000386	MF-712
120780	20:31266	OSTI; NTIS; INIS; GPO Dep.	E 1.99:	DE96000076	MF-712
120805	20:29778	OSTI; NTIS; GPO Dep.	E 1.99:	DE95017900	MF-703
120817	20:30189	OSTI; NTIS; GPO Dep.	E 1.99:	DE95017294	MF-706
120825	20:30564	OSTI; NTIS; GPO Dep.	E 1.99:	DE96001316	MF-706
120848	20:29148	OSTI; NTIS; GPO Dep.	E 1.99:	DE95015096	MF-900
120887	20:31267	OSTI; NTIS; INIS; GPO Dep.	E 1.99:	DE96000340	MF-712

Report Number	Abstract Number	Source of Availability	GPO Dep.	Order Number	Distribution Category
120907	20:30321	OSTI; NTIS; INIS; GPO Dep.	E 1.99:	DE96000378	MF-712
120920	20:30393	OSTI; NTIS; GPO Dep.	E 1.99:	DE96000260	MF-712
120968	20:30910	OSTI; NTIS; GPO Dep.	E 1.99:	DE95015127	MF-902
121019	20:30760	OSTI; NTIS; GPO Dep.	E 1.99:	DE96000362	MF-902
121047	20:30678	OSTI; INIS; NTIS; GPO Dep.	E 1.99:	DE96000366	MF-702
121076	20:30322	OSTI; NTIS; GPO Dep.	E 1.99:	DE95017298	MF-906
121086	20:30679	OSTI; NTIS; GPO Dep.	E 1.99:	DE96000365	MF-702
121090	20:30911	OSTI; NTIS; GPO Dep.	E 1.99:	DE95016618	MF-910
121119	20:30912	OSTI; NTIS; GPO Dep.	E 1.99:	DE96000682	MF-712
121125	20:31268	OSTI; NTIS; GPO Dep.	E 1.99:	DE96000092	MF-712
121127	20:31269	OSTI; NTIS; INIS; GPO Dep.	E 1.99:	DE96000341	MF-712
121128	20:31270	OSTI; NTIS; INIS; GPO Dep.	E 1.99:	DE95016608	MF-712
121130	20:30323	OSTI; NTIS; INIS; GPO Dep.	E 1.99:	DE96000342	MF-712
121148	20:31271	OSTI; NTIS; INIS; GPO Dep.	E 1.99:	DE95016609	MF-712
121180	20:31272	OSTI; NTIS; INIS; GPO Dep.	E 1.99:	DE96000726	MF-712
121193	20:30190	OSTI; NTIS; GPO Dep.	E 1.99:	DE96000395	MF-706
121195	20:31273	OSTI; NTIS; INIS; GPO Dep.	E 1.99:	DE96000074	MF-712
121197	20:31199	OSTI; NTIS; INIS; GPO Dep.	E 1.99:	DE96000343	MF-712
121198	20:31274	OSTI; NTIS; INIS; GPO Dep.	E 1.99:	DE96000093	MF-712
121200	20:31200	OSTI; NTIS; GPO Dep.	E 1.99:	DE95017295	MF-712
121202	20:30680	OSTI; NTIS; GPO Dep.	E 1.99:	DE95017075	MF-702
121235	20:30191	OSTI; NTIS; GPO Dep.	E 1.99:	DE95015892	MF-700
121246	20:30812	OSTI; NTIS; INIS; GPO Dep.	E 1.99:	DE95015900	MF-407
121271	20:31275	OSTI; NTIS; INIS; GPO Dep.	E 1.99:	DE96000094	MF-712
121281	20:31276	OSTI; NTIS; INIS; GPO Dep.	E 1.99:	DE96000753	MF-422
121286	20:31277	OSTI; NTIS; INIS; GPO Dep.	E 1.99:	DE95017862	MF-712
121331	20:30324	OSTI; NTIS; GPO Dep.	E 1.99:	DE95017822	MF-703
121345-Pt.1	20:30325	OSTI; NTIS; GPO Dep.	E 1.99:	DE95017818	MF-703
121345-Pt.2	20:29920	OSTI; NTIS; GPO Dep.	E 1.99:	DE96000089	MF-703
121355	20:29980	OSTI; NTIS; GPO Dep.	E 1.99:	DE95015907	MF-900
121433	20:30084	OSTI; NTIS; GPO Dep.	E 1.99:	DE96000350	MF-701
121439	20:30599	OSTI; NTIS; GPO Dep.	E 1.99:	DE96000348	
121447	20:28986	OSTI; NTIS; GPO Dep.	E 1.99:	DE96000418	MF-705
121452	20:31278	OSTI; NTIS; INIS; GPO Dep.	E 1.99:	DE95015984	MF-712
121456	20:31279	OSTI; NTIS; INIS; GPO Dep.	E 1.99:	DE96000754	MF-712
121501	20:30326	OSTI; NTIS; GPO Dep.	E 1.99:	DE95015989	
121502	20:29413	OSTI; NTIS; GPO Dep.	E 1.99:	DE96000088	MF-703
121506	20:30681	OSTI; NTIS; GPO Dep.	E 1.99:	DE96000100	MF-700; MF-705
121510	20:31386	OSTI; NTIS; GPO Dep.	E 1.99:	DE96000363	
121517	20:30913	OSTI; NTIS; INIS; GPO Dep.	E 1.99:	DE95017271	MF-700
121519	20:30565	OSTI; NTIS; GPO Dep.	E 1.99:	DE95017071	MF-410
121520	20:30555	OSTI; NTIS; GPO Dep.	E 1.99:	DE95017068	MF-410
121521	20:30566	OSTI; NTIS; GPO Dep.	E 1.99:	DE95017072	MF-410
121562	20:31031	OSTI; NTIS; GPO Dep.	E 1.99:	DE95016617	MF-910
121564	20:29149	OSTI; NTIS; INIS; GPO Dep.	E 1.99:	DE96000351	MF-900
121582	20:31201	OSTI; NTIS; INIS; GPO Dep.	E 1.99:	DE95016631	MF-712
121585	20:31280	OSTI; NTIS; INIS; GPO Dep.	E 1.99:	DE96000344	MF-712
121586	20:31281	OSTI; NTIS; INIS; GPO Dep.	E 1.99:	DE95016632	MF-712
121589	20:31202	OSTI; NTIS; INIS; GPO Dep.	E 1.99:	DE96000697	MF-731
121595	20:30581	OSTI; NTIS; GPO Dep.	E 1.99:	DE95017873	MF-900
121614	20:30394	OSTI; NTIS; INIS; GPO Dep.	E 1.99:	DE96000095	MF-712
121616	20:31387	OSTI; NTIS; INIS; GPO Dep.	E 1.99:	DE95017868	MF-712
121619	20:30327	OSTI; NTIS; GPO Dep.	E 1.99:	DE95017869	MF-706
121620	20:30192	OSTI; NTIS; INIS; GPO Dep.	E 1.99:	DE95017870	MF-712
121622	20:30556	OSTI; NTIS; INIS; GPO Dep.	E 1.99:	DE95017871	MF-712
121624	20:31282	OSTI; NTIS; INIS; GPO Dep.	E 1.99:	DE95017872	MF-712
121626	20:30395	OSTI; NTIS; GPO Dep.	E 1.99:	DE95017864	MF-712
121629	20:31203	OSTI; NTIS; INIS; GPO Dep.	E 1.99:	DE96000702	MF-712
121635	20:31388	OSTI; NTIS; GPO Dep.	E 1.99:	DE96000384	MF-700
121646	20:30396	OSTI; NTIS; INIS; GPO Dep.	E 1.99:	DE96000345	MF-712
121652	20:31283	OSTI; NTIS; GPO Dep.	E 1.99:	DE95017821	MF-712
121657	20:30328	OSTI; NTIS; GPO Dep.	E 1.99:	DE95017823	MF-705
121658	20:30193	OSTI; NTIS; GPO Dep.	E 1.99:	DE95017820	MF-700
121670	20:30914	OSTI; NTIS; GPO Dep.	E 1.99:	DE96000385	MF-700
121685	20:28987	OSTI; NTIS; GPO Dep.	E 1.99:	DE96001314	MF-721
121747	20:30854	OSTI; NTIS; GPO Dep.	E 1.99:	DE95016592	MF-705
121749	20:29989	OSTI; NTIS; GPO Dep.	E 1.99:	DE95016593	MF-702
121758	20:30085	OSTI; NTIS; INIS; GPO Dep.	E 1.99:	DE96000104	MF-704
121765	20:30682	OSTI; NTIS; GPO Dep.	E 1.99:	DE95017817	MF-705
121781	20:30346	OSTI; NTIS; GPO Dep.	E 1.99:	DE96000346	MF-405

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121813	20:31389	OSTI; NTIS; GPO Dep.	E 1.99:	DE95017706	MF-900
121817	20:31284	OSTI; NTIS; INIS; GPO Dep.	E 1.99:	DE96000751	MF-712
121819	20:31390	OSTI; NTIS; INIS; GPO Dep.	E 1.99:	DE96001320	MF-705
121827	20:30915	OSTI; NTIS; GPO Dep.	E 1.99:	DE96000420	MF-900
121831	20:30958	OSTI; NTIS; INIS; GPO Dep.	E 1.99:	DE96000701	MF-900
121878	20:30354	OSTI; NTIS; GPO Dep.	E 1.99:	DE96000361	MF-700
121891	20:30600	OSTI; NTIS; GPO Dep.	E 1.99:	DE96000382	MF-741
121922	20:28988	OSTI; NTIS; INIS; GPO Dep.	E 1.99:	DE96000812	MF-510
122072	20:30835	OSTI; NTIS; INIS; GPO Dep.	E 1.99:	DE96000078	MF-408
122096	20:30601	OSTI; NTIS; GPO Dep.	E 1.99:	DE96000392	MF-700
122100	20:30865	OSTI; NTIS; GPO Dep.	E 1.99:	DE96000391	MF-700
122108	20:30874	OSTI; NTIS; INIS; GPO Dep.	E 1.99:	DE96000354	MF-411
122110	20:29846	OSTI; NTIS; GPO Dep.	E 1.99:	DE96000396	MF-702
122170	20:31123	OSTI; NTIS; GPO Dep.	E 1.99:	DE96000367	MF-900
20441	20:31411	OSTI; NTIS; GPO Dep.	E 1.99:	DE96001315	MF-705
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119363	20:31285	OSTI; NTIS; INIS; GPO Dep.	E 1.99:	DE96000393	MF-700
121544	20:31391	OSTI; NTIS; GPO Dep.	E 1.99:	DE95017303	MF-705
121751	20:30866	OSTI; NTIS; GPO Dep.	E 1.99:	DE95017266	MF-705
UCRL-MA–					
105268-Rev.1	20:30086	OSTI; NTIS (documentation only); ESTSC (complete software package), P.O. Box 1020, Oak Ridge, TN 37831-1020 (United States); GPO Dep.	E 1.99:	DE96000381	MF-705
121327	20:31392	OSTI; NTIS; GPO Dep.	E 1.99:	DE95017806	MF-705
121344	20:30347	OSTI; NTIS; GPO Dep.	E 1.99:	DE96000821	MF-700
UCRL-PROP–					
117093-Vol.1	20:31286	OSTI; NTIS (US Sales Only); GPO Dep.	E 1.99:	DE95017677	MF-700
UM-P–					
94/03	20:31091	OSTI; NTIS; INIS		DE96602867	
94/113	20:31034	OSTI; NTIS; INIS		DE96602831	
94/115	20:31020	OSTI; NTIS; INIS		DE96602828	
94/117	20:29180	OSTI; NTIS; INIS		DE96602684	
94/118	20:30959	OSTI; NTIS; INIS		DE96602819	
94/120	20:30960	OSTI; NTIS; INIS		DE96602813	
94/123	20:30194	OSTI; NTIS; INIS		DE96602569	
94/124	20:31111	OSTI; NTIS; INIS		DE96602886	
94/126	20:30087	OSTI; NTIS; INIS		DE96602540	
94/129	20:30088	OSTI; NTIS; INIS		DE96602541	
94/130	20:30151	OSTI; NTIS; INIS		DE96602557	
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95/14	20:30252	OSTI; NTIS; INIS		DE96602532	
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95/16	20:30195	OSTI; NTIS; INIS		DE96602570	
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95/24	20:30867	OSTI; NTIS; INIS		DE96602803	
95/26	20:31139	OSTI; NTIS; INIS		DE96602961	
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95/29	20:31041	OSTI; NTIS; INIS		DE96602841	
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94-503	20:30699	*See* DOE/ID–22117			
95-112	20:28809	*See* DOE/ID–22118			

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USGS-OFR–					
95-160	20:30761	OSTI; NTIS; INIS; U.S. Geological Survey, Information Services, Box 25286, MS 517, Denver Federal Center, Denver, CO (United States) 80225-0046; GPO Dep.	E 1.99:	DE96000244	MF-2070
95-284	20:30762	OSTI; NTIS; INIS; U.S. Geological Survey, Information Services, Box 25286, MS 517, Denver Federal Center, Denver, CO (United States) 80225-0046; GPO Dep.	E 1.99:	DE96000243	MF-2070
USGS-WRI–					
94-4257	20:30700	*See* DOE/ID–22120			
UTNL-R–					
0323	20:29520	OSTI; NTIS; INIS		DE96701436	
WHC-EP–					
0394-10	20:29035	OSTI; NTIS; INIS; GPO Dep.	E 1.99:	DE95017147	MF-2010; MF-603
0474-17	20:28989	OSTI; NTIS; INIS; GPO Dep.	E 1.99:	DE95017142	MF-2030
0538-2	20:28990	OSTI; NTIS; GPO Dep.	E 1.99:	DE95017143	MF-2070
0573-3	20:28991	OSTI; NTIS; INIS; GPO Dep.	E 1.99:	DE96001069	MF-2010
0645	20:28992	OSTI; NTIS; INIS; GPO Dep.	E 1.99:	DE95017141	MF-2020; MF-510
0871	20:28993	OSTI; NTIS; INIS; GPO Dep.	E 1.99:	DE95017153	MF-2020
WHC-MR–					
0505	20:29118	OSTI; NTIS; INIS; GPO Dep.	E 1.99:	DE95015810	MF-2070
WHC-SA–					
2665	20:29036	OSTI; NTIS; INIS; GPO Dep.	E 1.99:	DE95015741	MF-2010
2781	20:28784	OSTI; NTIS; INIS; GPO Dep.	E 1.99:	DE95016337	MF-2000
2831	20:29150	OSTI; NTIS; INIS; GPO Dep.	E 1.99:	DE95015737	MF-2000
2834	20:29151	OSTI; NTIS; INIS; GPO Dep.	E 1.99:	DE95015738	MF-2070
2885	20:30683	OSTI; NTIS; INIS; GPO Dep.	E 1.99:	DE95016338	MF-2070
2902	20:29152	OSTI; NTIS; GPO Dep.	E 1.99:	DE95016339	MF-900
2925-FP	20:30763	OSTI; NTIS; INIS; GPO Dep.	E 1.99:	DE96001102	MF-2070
2931-FP	20:31412	OSTI; NTIS; GPO Dep.	E 1.99:	DE96001103	MF-2000
WHC-SD-CP-QAPP–					
016-Rev.1	20:30227	OSTI; NTIS; INIS; GPO Dep.	E 1.99:	DE96001067	MF-2020
WHC-SD-SNF-DGS–					
001	20:29119	OSTI; NTIS; INIS; GPO Dep.	E 1.99:	DE95015820	MF-2030
WHC-SD-W236A-RPT–					
010	20:28994	OSTI; NTIS; INIS; GPO Dep.	E 1.99:	DE95015787	MF-2030
WHC-SD-WM-DR–					
013	20:28995	OSTI; NTIS; INIS; GPO Dep.	E 1.99:	DE95016333	MF-2030
WHC-SD-WM-VI–					
020	20:28996	OSTI; NTIS; INIS; GPO Dep.	E 1.99:	DE95016331	MF-2020
WHC-SP–					
0665-17	20:30764	OSTI; NTIS; INIS; GPO Dep.	E 1.99:	DE96001070	MF-2030
0671-Rev.3A	20:29120	OSTI; NTIS; INIS; GPO Dep.	E 1.99:	DE95016343	MF-607
1138-Rev.1	20:30329	OSTI; NTIS; INIS; GPO Dep.	E 1.99:	DE96001631	MF-2000
1168	20:28785	OSTI; NTIS; INIS; GPO Dep.	E 1.99:	DE96001632	MF-2000
WR-B–					
95-08	20:31311	OSTI (Free of Charge)		TI96000689	PC-960

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WSRC-MS–					
94-0640	20:28997	OSTI; NTIS; INIS; GPO Dep.	E 1.99:	DE95017491	MF-2000
95-0184	20:28998	OSTI; NTIS; INIS; GPO Dep.	E 1.99:	DE96060001	MF-2020
95-0192	20:28999	OSTI; NTIS; INIS; GPO Dep.	E 1.99:	DE95017479	MF-721
95-0300	20:29858	OSTI; NTIS; GPO Dep.	E 1.99:	DE96060015	MF-700
95-0353	20:29000	OSTI; NTIS; GPO Dep.	E 1.99:	DE96060008	MF-700
95-0376	20:30228	OSTI; NTIS; GPO Dep.	E 1.99:	DE96060013	MF-702
95-0384	20:30348	OSTI; NTIS; GPO Dep.	E 1.99:	DE96060014	MF-706
95-0386	20:30330	OSTI; NTIS; INIS; GPO Dep.	E 1.99:	DE96060017	MF-706
WSRC-RP–					
93-1322	20:30684	OSTI; NTIS; GPO Dep.	E 1.99:	DE96060003	MF-702; MF-705
95-722	20:30782	OSTI; NTIS; INIS; GPO Dep.	E 1.99:	DE96060010	MF-702
95-89	20:30765	OSTI; NTIS; GPO Dep.	E 1.99:	DE95017488	MF-702
WSRC-TR–					
0137-2	20:30770	OSTI; NTIS; GPO Dep.	E 1.99:	DE96060004	MF-703
94-0609	20:30766	OSTI; NTIS; INIS; GPO Dep.	E 1.99:	DE95017468	MF-702
94-0618	20:29001	OSTI; NTIS; GPO Dep.	E 1.99:	DE95017481	MF-702
95-0012	20:29121	OSTI; NTIS; INIS; GPO Dep.	E 1.99:	DE95017507	MF-721
95-0016	20:30356	OSTI; NTIS; INIS; GPO Dep.	E 1.99:	DE95017492	MF-2070
95-0050	20:30767	OSTI; NTIS; INIS; GPO Dep.	E 1.99:	DE95017487	MF-702
95-0059	20:29002	OSTI; NTIS; INIS; GPO Dep.	E 1.99:	DE95017505	MF-721
95-0071	20:29003	OSTI; NTIS; INIS; GPO Dep.	E 1.99:	DE95017485	MF-721
95-0085	20:29004	OSTI; NTIS; INIS; GPO Dep.	E 1.99:	DE95017502	MF-2020
95-0138-1-Vol.1	20:29122	OSTI; NTIS; INIS; GPO Dep.	E 1.99:	DE95017509	MF-702
95-0138-1-Vol.2	20:29123	OSTI; NTIS; INIS; GPO Dep.	E 1.99:	DE95017494	MF-702
95-0138-1-Vol.3	20:29124	OSTI; NTIS; INIS; GPO Dep.	E 1.99:	DE95017495	MF-702
95-0145-2	20:30768	OSTI; NTIS; GPO Dep.	E 1.99:	DE96060005	MF-702
95-0230	20:29005	OSTI; NTIS; GPO Dep.	E 1.99:	DE96060006	MF-700
95-0276	20:30769	OSTI; NTIS; INIS; GPO Dep.	E 1.99:	DE96060002	MF-702
95-0502	20:29006	OSTI; NTIS; INIS; GPO Dep.	E 1.99:	DE95017476	MF-702
WZB-FS-III–					
94-102	20:29825	OSTI; NTIS (US Sales Only); INIS		DE96706576	
Y–					
2469-3	20:30089	OSTI; NTIS; INIS; GPO Dep.	E 1.99:	DE96000400	MF-704
Y/AMT–					
157	20:30331	OSTI; NTIS; GPO Dep.	E 1.99:	DE96000446	MF-700
Y/DW–					
1367	20:29181	OSTI; NTIS; INIS; GPO Dep.	E 1.99:	DE96000399	MF-713
Y/EN–					
5276/Rev.1	20:30783	OSTI; NTIS; GPO Dep.	E 1.99:	DE96000403	MF-702; MF-721
Y/NA–					
1801	20:28786	OSTI; NTIS (US Sales Only); GPO Dep.	E 1.99:	DE96000383	MF-700; MF-2000
Y/SUB–					
92-TK532C/4	20:30784	OSTI; NTIS; INIS; GPO Dep.	E 1.99:	DE96000402	MF-702
95-EAQ10C/1/P1	20:29125	OSTI; NTIS; GPO Dep.	E 1.99:	DE96000324	MF-702
95-EAQ10C/2/P1	20:29007	OSTI; NTIS; GPO Dep.	E 1.99:	DE96000323	MF-702
95-EAQ10C/3/P1	20:29008	OSTI; NTIS; GPO Dep.	E 1.99:	DE96000322	MF-702
Y/TS–					
1287	20:29007	*See* Y/SUB–95-EAQ10C/2/P1			
1375	20:30771	OSTI; NTIS; GPO Dep.	E 1.99:	DE96000401	MF-702
843/R2	20:29009	OSTI; NTIS; INIS; GPO Dep.	E 1.99:	DE96000296	MF-702

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WS Samoa

YE Yemen, Republic of
YU Yugoslavia

ZA South Africa
ZM Zambia
ZR Zaire
ZW Zimbabwe

Codes for International Organizations

ED EANDC [European American Nuclear Data Committee]
EP European Patent Office
IO ILO [International Labor Organization]
IX IUPAC [International Union of Pure and Applied Chemistry]
QS INSPEC [Information Service in Physics, Electrotechnology and Control]
QZ INPADOC [International Patent Document Centre]
WO WIPO [World Intellectual Property Organization]
XA IAEA [International Atomic Energy Agency]
XC CERN [European Organization for Nuclear Research]
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XE CEC [Commission of the European Communities]
XF FAO [Food and Agricultural Organization of the United Nations]
XH AAEA [Arab Atomic Energy Agency]
XI IIASA [International Institute for Applied Systems Analysis]
XJ JINR [Joint Institute for Nuclear Research]
XK WMO [World Meteorological Organization]
XN NEA [Nuclear Energy Agency of the OECD]
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XR ICRP [International Commission on Radiological Protection]
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THIS PUBLICATION CEASED WITH VOLUME 20, NUMBER 12 (DECEMBER 1995).